Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

Nature,
December 10, 1903.]

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME LXVIII

MAY to OCTOBER 1903

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

London
MACMILLAN AND CO., LIMITED
NEW YORK: THE MACMILLAN COMPANY

RICHARD CLAY AND SONS, LIMITED,
BREAD STREET HILL, E.C., AND
BUNGAY, SUFFOLK.

INDEX

REVIEWS AND OUR BOOKSHELF.

R. CLAY AND SONS, LTD., BREAD ST. HILL, E.C., AND BUNGAY, SUFFOLK.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, MAY 7, 1903.

THE SCIENCE OF FLOUR MILLING.

Le Froment et sa Mouture. Par Girard et Lindet. Pp. vii+355. (Paris: Gauthier-Villars, 1903.) Price 12 francs.

AT the time of the regretted death of Prof. Girard in 1898, much valuable scientific work had been accomplished by him, and the results given to the world at large. But as must almost of necessity occur when a busy man is taken away from his labours, there also remained some tasks commenced but not completed. Among these was a projected treatise on flour milling, of which, however, Prof. Girard left but the general plan and the unfinished manuscript of three chapters. These materials were entrusted to M. Lindet, who has completed the work and supplied the book now before us. The author refers to the fact that neither himself nor Prof. Girard was a practical miller, but that the book is the production of two men of science. An examination of its pages shows it to possess those merits which might be expected from the previous training of the writers, and also, it must be added, the defects which spring from the same cause.

The first chapter deals with the production of wheat in various French districts, and also with the corn markets of Paris and the provinces. In passing, it may be noted that in France, as well as in England, they still suffer from the adoption of different systems of weights and measures in the different local corn markets. Thus, Troyes has a unit of 121 kilos., while La Charente adopts 80 kilos. as its measure, and other markets intermediate quantities. The authors deplore the grave inconveniences which result from such differences, and look forward to a time when the metric quintal shall have been universally adopted. With France as the birthplace of the metric system, there is perhaps some consolation in knowing that England is not the only country ruled in this matter by old-fashioned conservatism.

Following on this introduction, the writers next deal with the chemical composition and the alimentary value of the different parts of the wheat grain. The botanical distinctions between such parts and their separation and estimation are first described, tables being given which show the relative percentages of envelopes, germ, and flour-producing kernel or endosperm in leading types of wheat. The histology, chemical composition, and analysis of the envelope are next given, particular attention being devoted to the constitution of cerealin and the important *rôle* it plays in the process of panification. In pursuit of this line of investigation, the influence of the various parts of the envelope on those milling products which ultimately find their way into the flour is examined very minutely. The experiments and arguments of Mège-Mouriès are followed closely, and his conclusions to the effect that the inclusion of branny particles in flour results in the production of dark-coloured and inferior bread are fully endorsed. The authors further conclude that the branny matters of wheat are devoid of utility for purposes of human alimentation, being practically undigested by man, and consequently inassimilable. An experiment made by Prof. Girard on himself is described at full length. Being in perfect health, and with the digestive faculties in excellent condition, he ate a quantity of pure wheat grain envelopes, and analysed these when excreted at the close of the process of digestion. The necessary precautions were of course taken to ensure exact and trustworthy data being obtained, and Prof. Girard's results show that there is practically no assimilation of proteid bodies from the bran ingested. There is, however, a certain absorption of mineral substances, but this only amounts to 4 grams of mineral matter per kilogram of bread made from "entire flour" (wholemeal). Having regard to the quantity and variety of such matter in a modern diet, the authors regard the gain of these 4 grams as having no serious importance, and, in a word, condemn entirely and without reserve the inclusion of the bran in wheaten flour.

In studying the action of the germ, the authors are impressed with the fact that fresh germ has a characteristic odour and flavour which are in themselves pleasant. They further recognise that germ contains

a large percentage of proteid and oily matter, in consequence of which the nutritive value is high. But the proteid matter contains an active ferment, and the oil is of a highly oxidisable nature, readily becoming rancid. For these reasons they do not hesitate to assert that the germ, as well as the bran, should be rejected in the act of making flour, the farinaceous endosperm being the only component of the wheat grain which ought to be used as human food. It is interesting to note that the problem of the utilisation of germ has been much more successfully attacked in England than on the Continent. The credit is due to an English miller of discovering the fact that on subjecting germ to the action of slightly superheated steam the diastasic properties of the proteids are destroyed, while the oil is so fixed as to lose its natural tendency to rancidity. Germ treated in this manner and then mixed with ordinary white flour produces a bread of pleasant flavour and of high nutritive value.

The endosperm or kernel of wheat consists principally of proteid matters, starch, and products of starch hydrolysis. Of these substances the proteid matter has received the closest attention, the whole general character of each particular variety of wheat, and of its resultant flour, being governed by the quantity and quality of the proteid bodies contained. It has been recognised from the time of Liebig to the present that the proteid matter of wheat is not a single compound, but a mixture of several distinct substances. Among these are small quantities of bodies soluble in water or dilute saline solutions respectively (albumins and globulins); but the greater portion is not soluble in either of these reagents, but forms with water a tough india-rubber-like body, to which the name of gluten has been given. This substance is readily prepared by carefully kneading and washing in a stream of water a piece of dough from wheaten flour. The starch and soluble matters are thus eliminated, and the gluten remains behind. The body thus obtained, known as wet gluten, contains about two-thirds of its weight of water, the remainder being approximately pure proteid. By appropriate means, gluten is capable of being separated into two, and possibly three, different substances, possessing distinct and characteristic chemical and physical properties.

The most exhaustive examination of these bodies has been made by Osborne and Voorhees, who in 1893 communicated their results to the *American Chemical Journal*. Following much the same lines of research as other investigators, they treated gluten and flour itself respectively with dilute alcohol (0.90 specific gravity). This reagent dissolves a considerable quantity of proteid matter from both the previously washed gluten and the untreated flour, the proteid being the same in both instances. (Albumin and globulin are insoluble in dilute alcohol.) To this proteid the name of gliadin has been given. Of gluten, the insoluble portion has been called glutenin. Osborne and Voorhees describe gliadin as being, when obtained in the dry state, from a solution in weak alcohol or water, an amorphous transparent substance closely resembling pure gelatin in appearance. It is slightly soluble in distilled water, but is instantly precipitated by a trace of common salt. Gliadin is very soluble in dilute alcohol (70 to 75 per cent.). As may be assumed from its mode of preparation, glutenin is insoluble in such alcohol, and also in water and dilute saline solutions. When freshly precipitated and hydrated, glutenin is soluble in 0.1 per cent. potash solution, and also in the slightest excess of sodium or potassium carbonate solution. Osborne and Voorhees made analyses of spring and winter American wheat flours respectively, each of which is a perfect flour of its kind, and found them to yield gliadin and glutenin in the following proportions:—

	Spring flour.	Winter flour.
Gliadin	45·8	48·4
Glutenin	54·2	51·6
	100·0	100·0

These quantities are roughly, it will be noticed, half and half, whereas M. Fleurent, whose results are adopted by MM. Girard and Lindet, states that the ideal composition of gluten is 75 parts of gliadin to 25 parts of glutenin. With such a composition the resultant bread will be well-risen and easy of digestion; but if the proportion of gliadin is higher, the bread will rise well during fermentation, but will fall in the oven, thus producing a heavy loaf as the result of the liquefaction of gliadin in the presence of water, under the influence of heat. But if the glutenin be in excess, the dough will be comparatively inelastic, and will not rise in baking.

There is evidently a great discrepancy between the results obtained by Osborne and Voorhees and those given in the work before us. It is to be regretted that MM. Girard and Lindet do not point out more clearly that in determining the percentage of gliadin M. Fleurent has made a radical departure from the method of Osborne and Voorhees. Instead of using pure dilute alcohol as a solvent, M. Fleurent employs 70 per cent. alcohol containing 3 parts of caustic potash per 1000. If, as stated by Osborne and Voorhees, glutenin is soluble in 0.1 per cent. potash solution, it is evident that it is readily soluble in a solution of the strength employed by M. Fleurent. After thus dissolving in dilute alcoholic potash solution, M. Fleurent passes carbon dioxide gas to saturation; but although potassium carbonate is insoluble in absolute alcohol, it is soluble in alcohol of 70 per cent., and so one has at the close of the experiment, not a solution of gliadin in dilute alcohol, but a solution of gliadin and a portion of the glutenin in a dilute alcohol-and-water solution of potassium carbonate. It is in consequence of this difference in their respective methods that the proportions of gliadin and glutenin found by these investigators differ so markedly from each other. No reflection whatever is cast upon the method of M. Fleurent as a means of judging the quality of a sample of flour, but it is unfortunate that the separation thus obtained is throughout spoken of by MM. Girard and Lindet as being one of gluten into gliadin and glutenin.

The examination of the more purely chemical part of this book has occupied space to the exclusion of the other subject-matter of the book. In later chapters

are contained an interesting historical *résumé* of the development of milling processes, which in turn is followed by a detailed description of wheat-storing buildings, silos, elevators and the like. The whole process of wheat cleaning, both by dry and wet methods, is described. In the next place, there is an account of the reduction of grain to flour, both by the old mill-stone process and the more modern one of gradual reduction by means of roller mills. The plan-sifter and other methods of separating flour from bran and germ next occupy attention. Having thus traced the whole operation from the raw grain to the finished flour, the authors devote a concluding chapter to flour analysis, modes of preservation, and a description of the channels through which, as a matter of commerce, it reaches the consumer. Of particular interest in this connection is the description of the "Twelve Marks" Market of Paris, and its mode of classifying and valuing flour according to a carefully selected standard of quality.

That M. Girard did not live to see the completion of his work is a matter sincerely to be regretted, but M. Lindet is to be congratulated on having produced, from the materials placed at his disposal and his own researches, a work of the keenest interest to chemists, and one that should prove of great value to the milling industry.

WILLIAM JAGO.

PHYSIOLOGICAL RESULTS.

Ergebnisse der Physiologie. Erster Jahrgang. II. Abteilung. Biophysik und Psychophysik. Pp. xviii+926. (Wiesbaden: Bergmann.) Price 25 marks.

IN the present day, when the man of science is becoming more and more overwhelmed by the ever-increasing flood of literature, any methods which can assist him in some degree to surmount the flood may cordially be welcomed. Year-books and Centralblätter are useful in affording abstracts of current literature, but such abstracts, necessarily disconnected, are apt to engender disconnection and incompleteness of thought in their readers. Moreover, mixed fragments of literature are exceedingly difficult to assimilate, in comparison with connected and critical surveys extending over a definite range of some stated subject. We must therefore express our warm approval at the publication of the first volumes of this new physiological annual. As the name might imply, this "Ergebnisse der Physiologie" is comparable in character to the well-known "Ergebnisse der Anatomie und Entwickelungsgeschichte," which has proved of great service to zoologists, and to the no less valuable "Ergebnisse der allgemeinen Pathologie." In the words of the editors (L. Asher and K. Spiro), the present "Ergebnisse" will consist of original and critical essays upon various subjects or special points in physiology, which as the result of fresh research have acquired an especial interest. As the "Ergebnisse" will appear annually, they hope that in course of time as far as possible every branch of the science will receive its due attention.

With this commendation, we may perhaps be permitted to offer some little criticism as to the range of subjects which the editors propose to include within their jurisdiction. Dealing only with what they term "Biophysik" and "Psychophysik," with which the volume under review is alone concerned (and which represent only half the complete annual), it appears that in addition to purely physiological matters, the editors intend to include essays covering a wide range of general physiology. The physiology of protoplasm is, of course, quite rightly included, but it is distinctly open to question whether biological problems such as inheritance and adaptation had not better be omitted. The present volume of "Ergebnisse," for instance, includes a very long article on Regeneration, although this subject is dealt with regularly every year in the aforementioned "Ergebnisse der Anatomie." Again, the editors intend to include articles on physiological psychology (*e.g.* simple psychical processes, reaction time, sleep, hypnotism). All these extraneous subjects go to swell the size of the volumes, and render them unwieldy. Thus this first year's issue runs to two volumes of about 900 pages each, or double the bulk of the anatomical "Ergebnisse," which in its earlier numbers much more reasonably confined itself to a single volume of about 700 pages. There must be many a working physiologist who would gladly subscribe to a volume of this character, but who would be deterred by the bulkiness and expense of the present issue. Moreover, it is difficult to see how the multiplication of articles in the present "Ergebnisse" can be kept up in the future, unless special points be dealt with in wholly unnecessary detail. So great is the total amount of ground covered that it almost seems as if one or two more years' issues would include the whole range of physiology. Subsequent essayists would accordingly have to rely almost entirely on new work, or their articles would practically resolve themselves into year-book abstracts. It is to be hoped, therefore, that the editors may see fit in future years to curtail the size of their volumes. This should be done, not only by diminishing the number of articles, but by diminishing their length. Many of the essays in the present volume, as, for instance, those of Prof. Tigerstedt on intracardial pressure, of Prof. Starling on the movements and innervation of the alimentary canal, and of Prof. Hensen on the physiology of hearing, are of a moderate and most convenient length; but others, such as those of C. v. Monakow on cortical localisation (132 pages), of A. Tschermak on adaptation of the eye to light, and the function of the rods and cones (106 pages), and of F. B. Hofmann on vision as affected by strabismus (46 pages), must be regarded as unnecessarily detailed, admirable as they may be in themselves. On the other hand, one or two articles err on the side of brevity, especially that of H. Boruttau on the innervation of respiration (6 pages), and to a less extent that of H. Meyer on nerve and muscle poisons (15 pages).

Another matter deserving of criticism is one which in future issues will doubtless to some extent be rectified. It concerns the lack of uniformity in the treatment of their subjects observed by the various essayists.

This is especially noticeable as regards the bibliography. Many of the essayists hit a happy mean, but H. Przibram actually gives 31 pages of references in his 77-page article on regeneration, whilst v. Monakow gives 846 distinct references, occupying 27 pages. Prof. Biedermann sins in the opposite direction, and in his otherwise comprehensive and instructive article on electrophysiology, sometimes mentions authors without giving any clue to their papers. Again, several of the articles are well illustrated (especially v. Monakow's important article on cortical localisation, which has eight plates), and it would be well if this most useful feature could be extended to certain other of the articles, though doubtless the question of expense comes in here.

In the limits of a short notice like the present one, it is impossible even to mention the titles of all the essays, but reference may be permitted to a few, over and above those already cited. P. Jensen gives a useful description of protoplasmic movement, and the effects of external conditions upon it, whilst J. von Uexküll writes a philosophical essay on the psychology of the lower animals. O. Langendorff enters very thoroughly into the properties of cardiac muscle, and discusses the nature of heart contraction, whether nervous or myogenic. L. Asher treats of certain aspects of the vaso-motor system, and R. du Bois-Reymond deals fully with the mechanics of respiration. H. E. Hering writes at some length on the central nervous paralysis of skeletal muscles (*e.g.* reflex inhibition, antagonistic muscles, decerebrate rigidity), whilst P. Grützner treats of the voice and speech, and H. Zwaardemaker of smell.

Finally, a word of praise must be accorded to the admirable manner in which the volume is printed. The large and well interspaced type renders reading a pleasure. Also printer's errors are remarkably infrequent.

H. M. VERNON.

PHYSICAL CHEMISTRY AND BIOLOGY.

Physikalische Chemie der Zelle und der Gewebe. Von Dr. Rudolf Höber, Privatdocent der Physiologie an der Universität Zürich. Pp. xii + 344. (Leipzig: W. Engelmann.) Price 9*s.* net.

THE keynote to this interesting volume is found in the beautiful quotation from von Humboldt with which the author introduces his preface.

"Es ist die Sitte derer, die gerne andere auf den Gipfel der Berge führen möchten, dass sie den Mitreisenden den Weg gebahnter und anmutiger schildern, als man ihn finden wird, und dass sie die Aussicht von den Bergen rühmen, auch wenn sie ahnen, dass ganze Teile der Gegend in Nebel verhüllt bleiben werden. Sie wissen, dass auch in dieser Verhüllung ein geheimnissvoller Zauber liegt, dass eine duftige Ferne den Eindruck des Sinnlich-Unendlichen hervorruft, ein Bild, dass im Geist und in den Gefühlen sich ernst und ahnungsvoll spiegelt."

The author proves himself in the subsequent pages of the volume just such an inspiring guide as this, and points out the varied prospects from many points of view in his different chapters.

The book is interestingly written throughout, and although space makes it impossible to mention all recent work in the applications of the new advancements of physical chemistry to biology, the work is thoroughly up to date in most important directions of this extensive field of research.

The author states in his preface that the book is intended as a first review of the subject for those who may subsequently study in larger text-books, and be stimulated thereby to aid in its development; but, in the opinion of the reviewer, the book will be found most interesting to those who already possess a considerable acquaintance with physical chemistry, and desire a comprehensive and suggestive review of its relationship to biology and physiology.

Parts of the subject, such, for example, as the development of the ionic theory, and equilibrium in solution, are from the size of the book presented in such concise form as to make anything but easy reading for a beginner at the subject; while others, such as the permeability of the cell membrane, the physical theory of the action of anæsthetics, absorption, secretion and lymph formation, form attractive reading, and demand little special previous knowledge of the subject.

The physical chemist owes to the biologist the earliest experimental work upon osmotic pressure and its relationship to molecular weight. It was the study of osmosis and osmotic pressure by Pfeffer and Traube on account of its relationship to cell life which chiefly led to the conception that substances in solution behave in certain respects like gases, and this formed the starting point for the physical chemistry of solutions.

For this early service biologists are now being repaid by the great opportunities which increased knowledge of physical chemistry is giving in the prosecution of the study of the chemical and physical processes taking place in the cell.

In this development of biology based on physical chemistry, the work is not being done solely by physical chemists, on the one hand, or by biologists on the other, but important contributions have been and are being made to the common store by both biologists and physical chemists. A perusal of the book before us demonstrates most clearly this mutual relationship between physical chemistry and biology, for in the names of authors one finds those both of important biologists and physical chemists.

It is along this line of physical chemistry, so far as one can foresee, that the most important and rapid growth in biology will take place in the near future, and hence it is most important for either following or taking a share in these developments that every biologist should also be acquainted with recent progress in physical chemistry. Certain portions of the book may specially be recommended to those who desire in a short space to learn something of the close practical relationship of physical chemistry to biology and also to medicine, such as that on the solubility of uric acid, urates, and the purin bodies, and on the action of indicators, pp. 88 to 101; the permeability of the cell-membrane, especially that portion dealing with the action of anæsthetics, pp. 101 to 134; action of ions upon cells, pp. 134 to 146, and 171 to 184; methods of

physico-chemical analysis, pp. 206 to 251; and lastly, the most interesting account given on pp. 272 to 315 of the physical chemistry of ferment action, and of Bredig's recent discovery of inorganic ferments.

The whole volume well deserves careful reading, and it is to be hoped that it will find a wide circle of readers amongst workers in all divisions of the very comprehensive subject of biology.

BENJAMIN MOORE.

OUR BOOK SHELF.

Contribution à l'Étude du Mode de Production de l'Electricité dans les Êtres vivants. Par M. le Dr. Louis Querton. Pp. 180. (Bruxelles: Lamartin, 1902.)

THIS contribution to the existing literature upon the subject of vital electromotive phenomena contains some new researches which support the view advocated by the author that the electrical changes in living tissues are caused by definite chemical processes. The view is not a new one, and its advocacy in the present publication appears to have been called forth by the attitude taken by Mendelsohn in his article upon the subject in the "Dictionnaire de Physiologie," edited by Prof. Richet; this attitude is described by Dr. Querton in the following quotation from M. Mendelsohn's article:—

"The conception of the chemical origin of the electrical phenomena observed in nerve and muscle is purely hypothetical."

Dr. Querton has done useful service in bringing together additional evidence that the electrical phenomena are in many cases the indications of definite chemical processes. The author gives a brief review of the general features of the phenomena in electrical organs, muscles, nerves, the eye, glandular tissue, the skin and the leaves of plants; he then describes observations of his own as to the direct connection between such electrical phenomena in plant leaves as are produced by the action of light and (photo-)chemical changes in the chlorophyll; he follows these by a description of photo-electric phenomena occurring in solutions of oxalic acid, &c.

As regards the general review, this is admittedly scanty, particularly in the part which deals with the electric organs of fishes, and in dealing with this portion of the subject the author does not appear to have recognised that recent observations point to the conclusion that the electrical organs of fishes are to be classed among nervous, and not among muscular, structures. The author's own researches show that electromotive effects may be rapidly developed, and may rapidly subside in correspondence with the similar development and subsidence of chemical changes of comparatively small amount, and this result appears to support the view of chemical causation which he advocates. It must, however, be admitted that in nervous tissues, chemical change is so slight or so masked as to give no indications of its occurrence unless, indeed, the electrical alterations are assumed to be such indications, an assumption which, for the purpose of the argument, is logically unsound. Even in the case of the pronounced electromotive effects observed in the electrical organs of fishes there is the same lack of evidence, and it would therefore seem that provided the chemical change is of a certain type, a relatively insignificant chemical alteration may be associated with very definite electromotive effect; in this connection the possibility of the occurrence of surface tension changes as the result of chemical alteration might have been treated by the author with great advantage.

The impression left on reading the author's conclusions is that, although these indicate that one antecedent of the electromotive phenomena observed in living tissues is chemical change, the more interesting question as to whether this chemical antecedent is a remote or an immediate factor in their causation remains untouched.

Statics by Algebraic and Graphic Methods. By Lewis J. Johnson, C.E. Pp. viii+134; with six plates. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 2 dollars.

FROM the preface we infer that the author has set out with the object of providing engineering students with a text-book of small compass in which the elementary parts of statics are treated on a deductive basis, and analytical and graphical methods of solution are treated side by side.

It cannot be said that the book fulfils either of these objects as adequately as it should. The proofs of the conditions of equilibrium and of the parallelogram of forces are so unsound that it would be far better to replace them by a few definite axiomatic statements. As an example, take the statement in the footnote on p. 14 (in connection with the moment of a force about a point), "For assuming the point to be fixed is really assuming it to be always subject to a force equal, opposite and parallel to the given one."

In regard to the graphic solution of problems, it is possible that when a student has been told how to draw a force diagram, he may apply the method to an example, and actually measure the lines representing the forces, the only drawback being that in the questions the angles of the figures are not specified, and the figures are too small to give good scale diagrams without this help. The so-called algebraic solutions are too suggestive of the well-known type of examination answer, "By taking moments the resultant can be found." This usually means that the candidate cannot find it. The best feature of the book is the set of six typical problems which are actually solved by both methods on the plates at the end.

De l'Expérience en Géometrie. Par C. de Freycinet. Pp. 178. (Paris: Gauthier Villars, 1903.) Price 4 francs.

THE author discusses the question whether geometry is purely a rational science or whether it also possesses an experimental side. The question is dealt with in connection with (1) the concepts of geometry, (2) geometrical axioms, and (3) the propositions the establishment of which forms the object of deductive geometry. In the first chapter, M. de Freycinet finds no *a priori* reasons for the existence of such concepts as space, straight line, curved line, plane or curved surface, volume, angle, parallelism, tangency. These and other concepts are all suggested to us by our perception of the material universe. Passing on to the axioms relating to the straight line and plane, the author considers that it can in no sense be regarded as a self-evident truth that the straight line is the shortest line between two points, that a straight line can be produced indefinitely in either direction, or that two straight lines cannot have two points in common. These and other similar facts can only be regarded as results of experience and observation. In comparing the purely geometrical methods of the ancients with the analytical methods of Descartes and Leibnitz, the latter methods will be found in reality to be no less concrete in their foundations than the former. They do not discuss the geometrical truths of which they make use, but they accept them as evident, relying on pure geometry to establish them.

The general conclusion is that geometry is largely based on the results of experience. M. de Freycinet's book should prove of great interest to all who devote attention to the teaching of geometry.

Étude des Phénomènes volcaniques: Tremblements de Terre—Eruptions volcaniques—Le Cataclysme de la Martinique, 1902. Par François Miron. Pp. viii + 320. (Paris: Ch. Béranger, 1903.)

THE ground which this little work is intended to cover is so vast that it is impossible for the author to deal with any part of the subject in an adequate manner. Seismology is dismissed in twenty-seven pages, which serve only to give a most misleading impression of the present state of our knowledge of that science. The ninety-nine pages devoted to volcanic eruptions furnish only a short sketch of the subject, such as may be found in any treatise on geology, though here and there matters not ordinarily treated of in text-books may be met with, such as Fouqué's method of collecting gas at fumaroles. The thirty-eight pages devoted to the causes of vulcanism contain summary statements of the views of de Lapparent, Fouqué, Stanislas Meunier, Gautier and others, the author giving greatest weight to astronomical causes as possibly determining volcanic outbursts! To the phenomena following volcanic eruptions sixteen pages are devoted, while an account of the principal volcanoes of the globe occupies forty-two pages. The description of the Martinique and St. Vincent eruptions has, however, seventy pages devoted to it, and the work concludes with chapters in which vulcanism and the riches of the globe are discussed, such matters as mineral veins, thermal springs, and the occurrence of petroleum being hastily passed in review.

It is difficult to understand what useful purpose a compilation of this kind can serve, but, as the author says in his preface, general attention has been attracted by the catastrophe of St. Pierre, and there seems to be a demand for some kind of popular information on the subject. The supply possibly meets the demand, but both are probably ephemeral.

Experiments with Vacuum Tubes. By Sir D. L. Salomons, Bart. Pp. vii+49. (London: Whittaker and Co., 1903.) Price 2s.

GIVEN a well-equipped physical laboratory and an expert glass blower as assistant, one could pass many a pleasant hour in repeating the experiments described in this little book. The phenomena exhibited by vacuum tubes are perhaps the most fascinating that electrical science can show; they possess a rare and peculiar beauty which, like that of the rainbow or the Aurora, appeals to both the æsthetic and the scientific senses. Sir David Salomons describes how tubes may be constructed to produce certain definite results in the arrangement of striæ and so forth, and many of the designs give evidence of painstaking ingenuity. A number of experiments with tubes and magnets are also described, some of which serve to illustrate well the mutual action of electric currents and magnetic fields. The author does not deal with those phenomena which, in the hands of Sir W. Crookes, J. J. Thomson and others, have led in recent years to results of such importance; indeed, the theoretical explanations which are given as a running commentary on the experiments seem rather to show a lack of appreciation of the essential facts which have added such interest to the behaviour of the electric discharge in high vacua, and have raised the vacuum tube from the position of a scientific toy to that of a powerful instrument of research.

M. S.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Energy Emitted by Radio-active Bodies.

PROF. J. J. THOMSON'S interesting article in last week's NATURE raises the question of how long the emission of energy by radium may be expected to continue. I think in this connection that it would be of great importance to determine, if possible, whether radium, as contained in pitchblende, emits as much energy as the same amount of the material in the form of an artificially concentrated product. The mineral must be supposed to have been in existence, in its present condition, for a period of time comparable with the age of the earth—perhaps 50 million years. It is certainly more likely to have lost than gained activity during that time. We may therefore reasonably assume that it has been liberating energy at not less than its present rate for 50 million years. A determination of the amount of energy thus emitted would carry us much further than the most careful and protracted observations on powerful radium preparations.

Such a measurement would, no doubt, be difficult, but not, I think, altogether impracticable. A very large block of pitchblende might be used, and a thermocouple inserted in the centre of it. Something might be gained by careful heat insulation of the block.

A rough calculation will show the rise of temperature to be expected.

Consider an infinite slab of pitchblende bounded by two plane faces, the axis of x being perpendicular to these faces. Take an elementary slice, of thickness δx, at distance x from the face, and bounded by planes parallel to it.

The outflow of heat per square cm. from this slice is $-k\frac{d^2\theta}{dx^2}\delta x$, where k is the thermal conductivity, and θ the temperature.

When a steady state has been reached, this must equal the rate of generation of heat in the slice per square cm. $= q\delta x$ suppose.

Thus $$-k\frac{d^2\theta}{dx^2}\delta x = q\delta x,$$

or $$\frac{d^2\theta}{dx^2} = -\frac{q}{k},$$

and by integration $\theta = \frac{-q}{2k}(x^2 + ax + b)$.

If the faces of the slab are maintained at 0° C., and if the slab is 1 metre thick, we have

$$\begin{cases}\theta = 0 \text{ when } x = 0, \\ \theta = 0 \text{ when } x = 100.\end{cases}$$

Thus $$a = -100, \ b = 0,$$

and $$\theta = \frac{-qx}{2k}(x - 100).$$

We may take for k the value 0.005, which is a rough general average for the conductivity of rocks.

It was found by Curie that 1 gram of radium emitted 100 calories per hour. If we suppose that the density of the radium is 3, and that pitchblende contains one part of it in 100,000 by volume, then, if the pitchblende is as active as one would expect from the proportion of radium contained, we should have

$$q = \frac{1}{1200000}.$$

We can now calculate the temperature to be expected at any point of the slab. In the middle, where $x=50$, we find

$$\theta = \tfrac{1}{8} \text{ nearly.}$$

So that the middle of the slab would be $\frac{1}{8}$° hotter than the faces.

In practice the difference of temperature available would be less, since the block used would not take the form of an infinite slab. But still, the effect would probably be measurable.

R. J. STRUTT.

The Fossil Man of Lansing, Kansas.

A GOOD deal of discussion has recently been aroused in America by the discovery of the so-called "fossil man of Lansing." It seems worth while considering the probable stature of the individual to whom the bones belonged. Prof. S. W. Williston, of Chicago, gives in the *Popular Science Monthly* for March (p. 470) the following values for the bone lengths, without, however, stating how the measurements were taken:—Femur, 43.0 cm.; Tibia, 35.0 cm.; Humerus, 30.2 cm.; Radius, 25.0 cm. From my memoir on the "Reconstruction of the Stature of Prehistoric Races" (*Phil. Trans.*, vol. cxcii. A, pp. 169–244), by using the formulæ on p. 196 Dr. Alice Lee has obtained the following results in cms.:—

Bones used in Reconstruction	Supposed ♂	Supposed ♀
(*a*) Femur ...	162·1	156·5
(*b*) Humerus	158·0	154·6
(*c*) Tibia ...	161·8	157·1
(*d*) Radius ...	167·7	164·8
(*e*) Femur + Tibia	161·7	157·0
(*f*) Femur, Tibia ...	161·7	157·0
(*g*) Humerus + Radius	162·4	159·8
(*h*) Humerus, Radius	159·7	155·5
(*i*) Femur, Humerus	159·6	156·0
(*k*) Femur, Tibia, Radius, Humerus	158·3	154·5

Now my experience of reconstruction shows me that with primitive races we do not get from formulæ based on modern data very consistent results when the radius is used.[1] I believe (*a*), (*f*) and (*i*) are the best formulæ to take in such cases. Effecting a perhaps not wholly defensible smoothing by taking means we have:—

Stature of Lansing individual	If ♂	If ♀
From all formulæ ..	161·3	157·3
From (*a*), (*f*) and (*i*) ..	161·2	156·5

The mean deviation of all the formulæ from the mean of the set is on the assumption that the bones belonged to a man 1·91, and on the assumption that they belonged to a woman 2·02. Thus the formulæ run from both aspects slightly more smoothly if we assume the bones to be those of a man. The skull may possibly offer, on closer study, some balance of characters on which to form an appreciation as to sex. Prof. Williston's photographs, having regard to the lower mandible and brows, do not seem wholly inconsistent with the male sex.

As to the date of the Lansing bones, this can only be settled by the geologists on the spot. But if the period be at all comparable with that of Palæolithic man in Europe, of whom, I think, we may put the best available estimate of stature to be 162·7 cm., the American and European statures, so far as such slender evidence goes, are not widely apart. If, on the other hand, we take the bones to be those of a woman, the stature of 157·3 cm. would correspond to a male stature of 169·0 cm.—a value considerably above that of Palæolithic man in Europe, or, indeed, of Neolithic man.

Hence I would suggest the following points for consideration:—

A. *The bones are those of a man.*

If they belong to those of an "early" American man,

(*a*) He was, if a normal example, of much the stature of Palæolithic man in Europe.

(*b*) He must have been a short man for his race, if early American man was much taller than the European Palæolithic man.

B. *The bones are those of a woman.*

If they belong to those of an "early" American woman,

(*a*) The early Americans, if she were a normal example of a woman, had a male stature of 169 cm., and were a taller race than early European man.

(*b*) She must have been a tall woman for her race, if early European and American men were at all similar in stature.

The stature of the American Indian is very considerable; if, therefore, a great antiquity can be predicted, *i.e.* if the silt would seem to show that the bones have been many thousand years embedded, the importance of determining the sex becomes obvious. No dogmatic statement, remembering the variability of human stature, can be made, but the find gives a *slight* probability in favour of American early man and European Palæolithic man not diverging widely in stature, if the bones are male, but, on the other hand, if the bones are female, they give a *slight* probability in favour of American early man being much taller than European Palæolithic man.

[1] Everything tends to show a shortening of the radius relative to the length of the other long bones, since early times.

It is easy to make irresponsible suggestions at a distance, but is it not possible for a systematic investigation to be made by excavating the whole, or a large part, of the deposit upon the limestone bed at Concannon's house, with the hope of discovering further human remains, or signs of human handicraft?

KARL PEARSON.

Reform in School Geometry.

THE reviews in your issue of April 23 tend to confirm an apprehension I have long felt. Euclid is to be abolished, and another sequence of propositions substituted. But it is probable that in many cases the same old methods of teaching will be retained, the same old drudgery of learning propositions and not learning to think, will be gone through by the future generation as it has been gone through by the past. The only difference will be that the one redeeming feature of the old system, the semblance of a logical sequence, will be abolished, and students will be commended instead of condemned for assuming constructions before they have learnt how to perform them. They will also be encouraged to base their proofs on such difficult-to-be-understood concepts as *direction*.

Now it appears to me that instead of the new geometry being a recent innovation, its essential features are pretty well laid down in the "Treatise on Geometry" published in 1871 by the late Dr. Watson (Longmans' Text-books of Science). The disadvantages of Euclid's order of treatment, the use of hypothetical constructions, the importance of loci, the classification of propositions, all these and many other points on which stress is now laid are discussed in Dr. Watson's preface. Whether or not would-be reformers of mathematical teaching have studied Watson, it is interesting to find the supposed "modern up-to-date improvements" in the teaching of geometry so closely forestalled in a book of thirty years ago, just as the so-called "modern free wheel" was commonly fitted to tricycles from 1879 onwards, until cyclists were glad when a substitute was invented.

G. H. BRYAN.

I WILL not deny that some reformers desire to abolish Euclid and establish another sequence of propositions in abstract geometry for schoolboys; but if Prof. Bryan reads the reviews which he cites more carefully, he will see that the reform current is very strong in quite another direction, and that his long-held apprehension is altogether baseless. I think that I apprehend the idea underlying the efforts of the majority of the reformers. It is the very old idea that the average English boy may be educated through the doing of things rather than through abstract reasoning. If abstract geometry is to be retained as a school subject, it can only in the future, as in the past, do harm to 98 per cent. of the boys; we say, drop it altogether in schools, and think of it only in connection with the universities. Two per cent. of schoolboys take to abstract reasoning as ducks take to water, and they ought not to be discouraged from the study of Euclid, but they and all the other boys ought to study geometry experimentally, logic entering into the study just as it enters into other parts of experimental physics. If the best modern books have a fault, it lies in the absurd assumption that an experimental sequence ought to have some connection with the Euclidean sequence.

JOHN PERRY.

Can Dogs Reason?

MY account of an experiment which you allowed me to record in NATURE of April 16 has been copied into a number of newspapers, and has brought me no few letters. Some of my correspondents explain the negative results of the box-meat experiment by supposing that the dog was too well trained to "steal" the meat. They have not noticed that I was careful to point out that the box was placed in the yard in which the dog is accustomed to be fed, that

he was very eager to get the meat out of it, and that when later in the day he succeeded, he showed no manner of misgiving as to his legal right to its possession.

Other of my correspondents misunderstand the purpose of the experiment. They see in it a desire to belittle their canine pets. This was very far from my thoughts. We have innumerable anecdotes telling us what dogs can do. I wish, partly I admit with a view to enabling us to sort these stories, to obtain, as data, definite observations showing what dogs will not do. Into most dog stories there creeps the little touch of human nature which makes them and ourselves akin.

Mine is the point of view of an anatomist. A dog has a brain very different from that of man. Brain and mind are the two sides of the same coin; or rather, brain is the coin, mind its value. The dog's brain cannot make a man's thoughts. How near can we come to picturing to ourselves the nature of a dog's thoughts? Without committing ourselves to Flechsig's theory of the division of the cortex of the brain into "projection areas" and "association areas," we may on anatomical grounds assert that the cortex of a dog's brain contains fewer association elements than does that of a man. It is an apparatus for transforming sensory impressions into actions, in a more limited and exclusive degree. Probably we can best picture to ourselves the work that it does by supposing that the wordless thoughts of animals are direct combinations of sensory impressions; whereas man has invented symbols for his sensory impressions. He works the symbols into thought. Nor do his symbols stand for material objects alone. They also stand for inferences from observations. But this is a subject which perhaps I ought not to touch without having at my disposal more space than I can ask you to give me in your Journal.

We must admit with Sir William Ramsay that dogs make use, in their mental operations, of sensory impressions and not of inferences, although I dissent from his qualification of their impressions of smell as "vague." It is my object to ascertain, by means, if possible, of observations which can be made under properly controlled conditions upon numerous dogs of various breeds, the limits of their power of substituting inferences for sensory impressions as materials of thought.

Perhaps I may be allowed to use a new nomenclature in defining the position in which, as it appears to me, we stand with regard to the axioms of animal psychology at the present time. An animal remembers. When it performs an action a picture of the action is stored in memory. If the result of the action be satisfactory, a picture of this result is stored in memory. When in future the animal desires to obtain the result it repeats the action. This we may call the product of "reasoning in the first degree." Action depends upon inference. We may accept it as an axiom that an animal can draw an inference of this kind. It is not yet established, by experimental methods, that an animal can combine two inferences, or, as I venture to term it, "reason in the second degree." My box-experiment was intended to throw light upon this question. I shall be very grateful for any further suggestions of possible experiments of the same kind.

ALEX. HILL.

Downing Lodge, May 2.

Spherical Aberration of the Eye.

WITH reference to the experiment described by Mr. E. Edser (p. 559) as appearing to have "escaped observation," perhaps I may be allowed to state that this phenomenon was (to the best of my recollection) described by me before the School Natural History Society when I was a boy at Rugby, about 1873–1874. I could not explain it, and no one at the meeting had any suggestion to make.

I think I connected it in my mind with irradiation phenomena, though I was baffled by the fact that the *whole* line is bent.

If the black horizontal lines drawn between different advertisements on the outside of NATURE be held five or six inches from the eye, and the rounded end of a pen be brought down close to the eye, the whole line will be seen to curve upward to meet the pen, becoming also blacker and more distinct.

W. L.

THE phenomenon mentioned by W. L. must have frequently been noticed; while resembling that described by me as a proof of the spherical aberration of the eye, it is yet due to an essentially different cause. The black line, when placed at a distance of five or six inches from the eye, is within the shortest distance of distinct vision from the latter. A point source of light, situated on the axis of the eye, at a position closer to the eye than the "near point," produces a relatively large spot of light on the retina. If the pupil be now progressively covered from above, the rays passing through the middle and upper part of the pupil will be cut off, so that those passing through the lower part of the pupil alone remain; these cut the retina in a comparatively restricted area below the point of intersection by the axis of the eye, so that the image apparently rises, at the same time becoming more sharply defined. Under the conditions mentioned, the same phenomenon would be observed if the eye were entirely free from spherical aberration. For this reason I stated that the black band should be placed "just beyond the shortest distance of distinct vision from the eye; . . . care must be taken to keep the eye carefully focused on the edge of the black band, or an exaggerated displacement, due to relaxation of the accommodation of the eye, may result." It was merely as a proof of the spherical aberration of the eye that I described this experiment as having apparently escaped observation.

April 12. EDWIN EDSER.

IN connection with the experiment on the spherical aberration of the eye, described in your issue of April 16, I may relate a striking observation I made some years ago. Regard with one eye any light or bright object on the wall, turn the head away until the object is just covered by the line of the nose; then move the eye to its natural position, and the object will reappear, supposing the nose is not too prominent. Moving the eye several times to and fro, the phenomenon will be easily observed.

Leipzig, April 29. W. BETZ.

THE SOLAR AND METEOROLOGICAL CYCLE OF THIRTY-FIVE YEARS.

THE fact that the rainfall of many regions of the earth's surface has, for the last decade or more, been gradually diminishing has led many inquiries to be made concerning the possible periodicity of this meteorological element, and during the last few months more general attention has been drawn to this interesting question. The great importance of this inquiry, not only to agriculturists but to others, renders it desirable that all facts which may tend to elucidate the subject should be thoroughly discussed.

The object of the present article is to bring together, without entering into too great detail, a few statistics relating to the rainfall of different stations in various parts of the earth to see whether there be grounds for assuming a continuation of the present small supply, or whether a greater abundance may be looked for with special reference to the condition of the British Isles.

A few introductory remarks may here not be out of place. Eduard Brückner first discovered that wet periods, great droughts, &c., occurred at intervals of about thirty-five years, and he published his important conclusions in a volume which was, and still is, a valuable contribution to meteorological science. To take one element only, namely, rainfall, Brückner showed that during the last century the mean epochs of the wet years were 1815, 1846–50, and 1876–80, while those for the dry years were 1831–35 and 1861–65.

Since the publication of this volume, many workers have studied rainfall and other records extending over long periods of time. Thus, to take one instance among many that might be cited, Herr Hofrath Julius Hann, the distinguished late director of the Vienna Meteorological Institute, made a minute investigation of the

rainfalls of Mailand, Padua, and Klagenfurt, and found a well-marked recurrence of the wet and dry periods every thirty-five years, the mean epochs of the former being 1808, 1843, and 1878, and of the latter 1823, 1859, and 1893.

In determining the variation of rainfall over such long periods as that of thirty-five years, it is necessary, if possible, to smooth the curve representing the variation from year to year, for this curve, as a rule, displays large fluctuations from the normal in the course of a very few years, and it is not easy for the eye to grasp the longer periods of variation; these long periods may to some extent be rendered more apparent by coupling up together the mean values of the rainfall for several years, and forming another mean, but somewhat fictitious value, for each successive year. Thus, for instance, the mean for one year, say 1870, might be computed from the means of the five years 1868 to 1872, or the means for 1871 from the mean of the years 1869 to 1873; instead of a five-year mean, a ten-year or a fifteen-year might be chosen.

In the figure here given, five-year means have been adopted, and the curves resulting from these have been further smoothed by drawing freehand another curve to eliminate as far as possible the smaller fluctuations of short period that still exist, even after still minor changes have been eliminated. The stations, the rainfall curves of which are here given, have not been specially selected, but simply taken as the data for them were easily available, and they afforded long records for the study of such variations as are here discussed. The short curve for the British Isles is attached so that not only can a comparison be made of this record of the Meteorological Office with that obtained by the late Mr. Symons, but that the actual variation over the islands taken together can be compared with two widely separated stations in them, as Greenwich and Rothesay. The European continent is here represented by Brussels, the epochs of the maxima and minima of the rainfall curve of which can be compared with the values given by Hann and referred to in a previous paragraph. Two stations in India, Bombay and Madras, one station in South Africa, Cape Town Observatory, and lastly three stations in the United States of America representing the rainfall of the Upper Ohio Valley, complete the rainfall information here given.

A general collective glance at these curves shows that there is an undoubted long period variation in all the stations here brought together. Further, that the periods of greatest rainfall occur *generally* in the years 1815, 1845, and 1878–83, while those at which the rainfall is decidedly deficient are about the years 1825–30, 1860, and 1893–5.

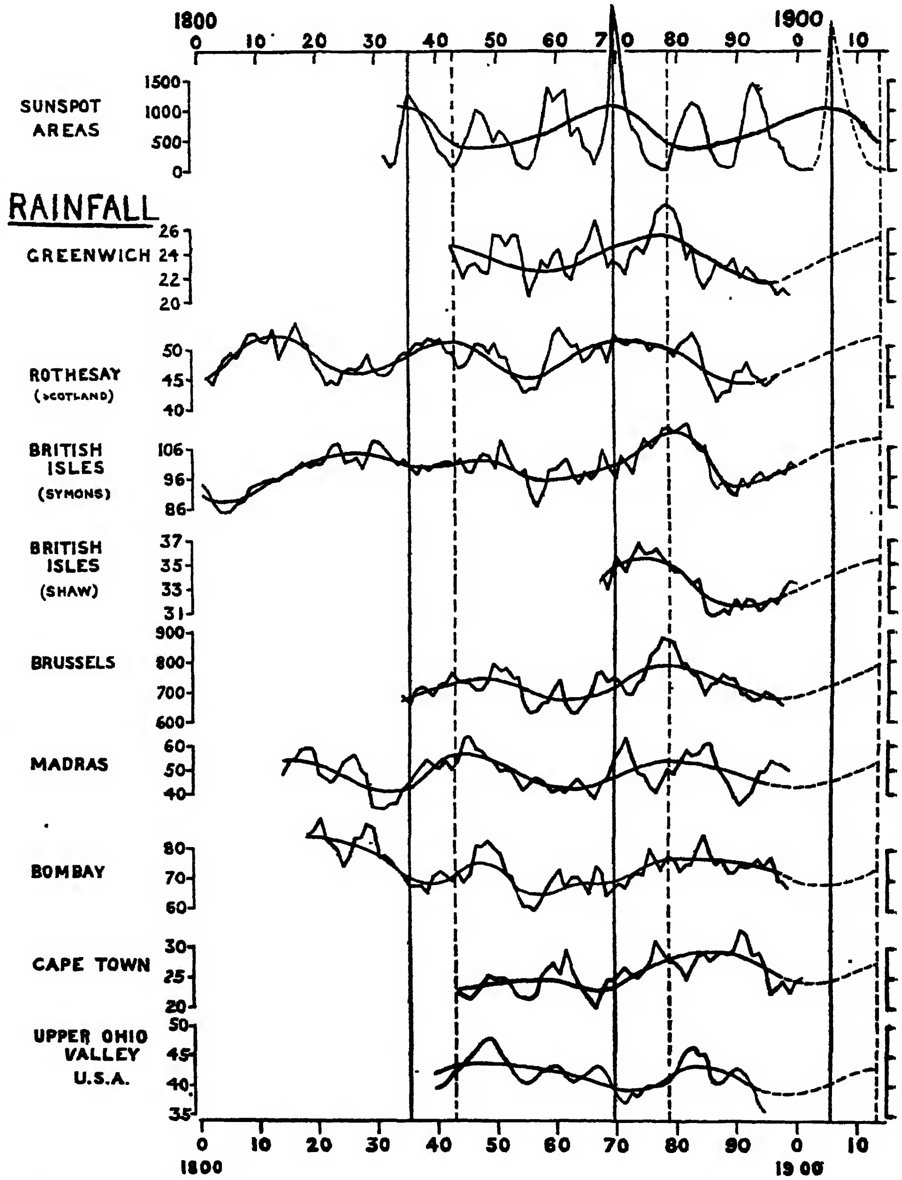


FIG. 1.—Curves showing the relation between the 35-year sunspot period and that of the Brückner rainfall cycle. Each of the rainfall curves is determined from the means of five-years, and these curves are smoothed by freehand drawing in order to show the long period variation of rainfall. The smoothed curve through the eleven-year sunspot curves indicates the epochs of the long period sunspot variation.

With the existence of these very definite fluctuations it is important to notice that the last minimum or dry period which is most apparent in the case of the curves representing the British rainfall seems now to be just

past, or on the point of coming to a conclusion, and in all cases the general tendency of the long period curve is now to rise again. This indication of the increase of the rainfall is represented in the figure by the dotted continuation of the secular variation curves for each station, and should the apparent law hold good, there seems sufficient evidence to mark that this rise will continue to take place until about the year 1913, which year will suggest the middle of the next wet epoch.

It may be mentioned, however, that owing to the great oscillatory nature of the rainfall from year to year, this rise only represents the mean rise when several years are coupled together; there may be comparatively dry years even when the secular variation curve is at a maximum, but on the average they will probably be wet.

What causes this long period of weather variation is not yet definitely known, but it is of the highest importance to meteorological science that the matter should be cleared up as soon as possible, for not only is our rainfall involved, but all other meteorological elements show similar fluctuations.

Brückner attempted to account for this long period weather cycle by attributing its origin to a change in the activity of the sun, and he investigated the sunspot data then available for evidence of a periodicity of about thirty-five years. He was not, however, successful in his research, but he concluded that, although this variation must really exist in the sun, yet it might not necessarily be indicated by sunspots. More recently a minute examination of the sunspot observations made since the year 1832, when a systematic method of observation had been initiated, has led to the discovery of such a period, a detailed account of which appeared in a previous number of this Journal (NATURE, vol. lxiv. p. 196). It was there shown that each sunspot period (reckoning from minimum to minimum) differed in many respects from the one immediately preceding or following it. Some periods, for instance, were not only more "spotted" than others, that is, the summation of the whole spotted area from one minimum to the next varied regularly, but these particular periods were closely associated with comparatively rapid rises from minimum to maximum in those periods. These changes further seemed to be undergoing a regular variation, the cycle of which was determined to be about thirty-five years.

The connection between Brückner's cycle and this long period solar change of thirty-five years was there briefly stated, and it was shown that at those two epochs of sunspot minima, namely, 1843 and 1878, which follow the cycles of greatest spotted area, the Brückner rainfall cycle was at a maximum.

The close correspondence of the epochs of these two cycles suggested at once a probable cause and effect, a cause which Brückner himself had suggested and looked for, but unfortunately did not find.

In the accompanying figure the uppermost curve represents the sunspot curve from the year 1832, and the minima just referred to are indicated by the vertical dotted lines, which are continued through all the curves. The periods of greatest spotted area just precede these epochs, and the times of maxima are shown by the vertical continuous lines drawn in a similar manner. To show the probable times of the recurrence of these epochs during a portion of the next great period of thirty-five years two vertical lines have been inserted at the years 1905, which is the probable epoch of the next great maximum, and 1913, the following minimum, so that their relation to the probable variation of rainfall, as indicated by the dotted portions of the curves, can be seen at a glance.

In conclusion, attention may be drawn to the fact that during the last few years a far more close connection between solar and meteorological phenomena has been made out than was the case some years ago, and since this long period rainfall cycle synchronises so well with the solar changes, the latter may render valuable assistance in determining the epochs of these dry and wet cycles. WILLIAM J. S. LOCKYER.

ETIOLATION.[1]

THIS monograph is published by the aid of the Daly Lydig fund bequeathed by Charles P. Daly, and embodies the results of the author's investigations extending from 1895 to 1902, and one of the first questions it arouses is, to what extent is this sustained experimental work stimulated by the certainty of adequate publication owing to the generosity of patriotic endowment, and to what extent does such work react on the pockets of friendly millionaires and induce the endowments for further work? In any case, Americans are fortunate in their circumstances in these respects.

The book, which comprises more than 300 pages of text and 176 figures, all admirably done, is divided into three principal sections. There is, first, a summary of the history of the subject, beginning with Ray (1686) and Hales (1727), and occupying 34 pages of more or less critical notes. It is, of course, impossible for us to verify the enormous number of the references to this part of the subject, but if the author has made many such blunders as those on pp. 27 and 29, where on two separate occasions he cites volumes and pages as from *Proc. Roy. Soc.* when he should have written *Philosophical Transactions*, the value of his bibliography must suffer. If a leading American plant physiologist does not know the difference between the two publications referred to, it is time he did; if he *does*, the inference that he has not consulted the original memoirs is as inevitable as it is dispiriting.

The second chief division of the work occupies the bulk of the book, pp. 35–200, and reflects credit on the author and his pupils for their industry and clearness of description, as well as for the interesting choice of plants selected for experiment. These include not only ordinary flowering plants, but also more out of the way forms of monocotyledons and dicotyledons, as well as ferns, Equisetum, &c. The one note of disappointment in this portion of the book will be struck by the want of plan. Numbers of most interesting observations on the behaviour of particular species in the dark, and illustrations of their facies, their anatomy compared with that of normal plants, their curves of growth and so forth will make the book useful to all investigators; but the plants are arranged in alphabetical order, and when the reader turns to a particular species he has no guide as to how it will be treated. Thus, taking at random Salvia, Sansevieria, Sarracenia, Saururus, and Sparaxis, which follow in the order given on pp. 171–180. The first merely heads a small paragraph stating that the corolla is atrophied in darkness. Under Sansevieria the etiolation of the shoot is described only in so far as external changes are concerned. In Sarracenia the effects of etiolation on the histology of the epidermis lining the "pitchers" are well illustrated. In Saururus figures of the anatomy of etiolated and normal stems, and measurements of height and thick-

[1] "The Influence of Light and Darkness upon Growth and Development." By D. T. Macdougal, Ph.D., Mem. New York Bot. Garden. Vol. ii. Pp. xiii + 319. (1903.)

ness form the theme; while Sparaxis heads a short paragraph recording failure of growth.

All this suggests a heterogeneous collection of student's notes as the groundwork of the memoir, and interesting and useful as many of these are, they might have been rendered more valuable by classification and efficient editing.

The third portion of the book is occupied with general considerations, and embraces summaries of the foregoing, theories as to the nature of etiolation, and so forth.

Here, of course, we look for the author's own views, but with the exception of vague statements here and there, the concluding portions of the book force us reluctantly to decide that, important and interesting as the memoir is, it is so not so much as a work of original thought and suggestion, but as an extensive and more or less critical survey of what others have done. In this category it stands well, and may be recommended, but we do not like such sentences as the following exercise for the grammarian and the physicist:—

"It is, of course, entirely probable that the action of light may set up chemical processes in the plant is in a manner entirely stimulative, and independent of any communication or transformation of energy" (p. 201).

PROF. J. WILLARD GIBBS.

THE announcement of the death of Prof. J. Willard Gibbs, of Yale University, will be received with the deepest regret by the whole of the scientific world.

There are few workers who have done so much as Prof. Willard Gibbs to teach the lesson that it is to the mathematician that the experimentalist must look for new ideas. The papers which have made his name famous date from 1873, when he published in the *Transactions* of the Connecticut Academy his paper on the geometrical representation of the thermodynamical properties of bodies. Gibbs first discussed the advantages of using different thermodynamical variables for graphic representation, and then discussed the surface formed by taking as coordinates the volume, entropy and energy of a body. "Gibbs's thermodynamical model," or "thermodynamic surface" as it is now called, has become best known to English readers through the account given in Maxwell's "Theory of Heat." The study of the properties of thermodynamical surfaces has afforded a wide field of research, which is still continuing to yield new results in the hands of the Dutch school of physicochemists. A remarkable feature of the investigation is the geometric representation of the conditions of thermodynamic stability, which does much to remove the difficulties attaching to any algebraic form of enunciation. A further paper, entitled "Graphic Methods in the Thermodynamics of Fluids," was published in 1878.

Gibbs's epoch-making papers *par excellence* are, however, those dealing with the equilibrium of heterogeneous systems, the first of which, dealing with chemical phenomena, was published in June, 1876, while the second, dealing with capillarity and electricity, appeared in July, 1878. The most essential feature of Gibbs's discoveries consists in the extension of the notion of the thermodynamical potential to mixtures consisting of a number of different components, and the establishment of the properties that this potential is a linear function of certain quantities which Gibbs has called the potentials of the components, and that where the same component is present in different phases which remain in equilibrium with each other, its potential is the same in all the phases, besides which the pressures and temperatures of the phases are equal.

The importance of these results was not realised for a considerable time. It was difficult for the experimentalist to appreciate a memoir in which the treatment is highly mathematical and theoretical, and in which but little attempt is made to reduce conclusions to the language of the chemist; moreover, it is not unnatural to find the pioneer dwelling at considerable length on comparatively infertile regions of the newly-explored territory, while points of vantage which have subsequently proved to be the most productive fields of study were dismissed very briefly. It was largely due to Prof. van der Waals that two new and important fundamental laws were discovered in the paper, namely, the phase rule and the law of critical states, and the consequences of the first of these laws were the subject of remarkable developments in the hands of Bakhuis Roozboom, Schreinmakers, Stortenbeker and Wilder Bancroft. The well-cultivated tracts of knowledge which represent a most important branch of modern physical chemistry bear but little resemblance to the crude, often circuitous path, full of stumbling blocks and difficult obstacles by which Gibbs first opened up this region. The study of dissociation phenomena has afforded some of the most beautiful experimental verifications of Gibbs's theories, which have done much to convert theoretical chemistry into a branch of applied mathematics.

It is not the physicist and chemist alone who are indebted to Prof. Gibbs; he has also made his mark among mathematicians in connection with the study of quaternions and vector algebra. Physicists claim that in the Hamiltonian system of quaternions there is a loss of naturalness from the fact that the square of a vector becomes negative. Gibbs met the objection by suggesting an algebra of vectors with a new notation, the expression for the product of two vectors being formed in such a way as to give a positive value for the square of a vector. His paper on "Multiple Algebra" was published in the *Proceedings* of the American Association for 1886.

Gibbs's attention has recently been turned to remodelling the mathematical theories underlying the kinetic theory of gases, and the law of partition of energy. His work on statistical mechanics has been before us for about a year, but so difficult is the subject that a considerable further time must elapse before it can be widely understood and appreciated. His interpretation of the determinantal equation as the principle of conservation of extension in phase, his methods of dealing with ensembles of systems, and his establishment of the existence of irreversible phenomena in connection with such ensembles are all distinct advances, but in connection with the last-named properties an idea necessarily forces itself on one that there must be some assumption underlying the proof which might with advantage be discussed more explicitly than was done in the treatise in question, and his loss at the present time deprives us of the prospect of further enlightenment on difficulties which no amount of mere mathematical formulæ will clear up.

As mentioned last week, he was elected Foreign Member of the Royal Society in 1897, and received the Copley medal in 1901. He was also an honorary or corresponding member of the British Association, the Cambridge Philosophical Society, and many other learned societies both in this country and abroad.

G. H. B.

NOTES.

THE annual conversazione of the Royal Society will be held on Friday, May 15.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the Society:—Dr. W. M. Bayliss, Prof. T. W. Bridge, Dr. S. Monckton Copeman, Mr. Horace Darwin, Mr. W. P. Hiern, Mr. H. R. A. Mallock, Prof. D. Orme Masson, Mr. Arthur G. Perkin, Prof. E. Rutherford, Prof. R. A. Sampson, Mr. J. E. Stead, Mr. A. Strahan, Prof. J. Symington, Prof. J. S. Townsend, and Mr. A. N. Whitehead.

AT the annual general meeting of the Institution of Civil Engineers, held on April 29, Sir William H. White, K.C.B., F.R.S., was elected president for the sessional year 1903–1904.

DR. P. CHALMERS MITCHELL has been elected secretary of the Zoological Society in the place of Mr. W. L. Sclater, who held the office as acting secretary since the retirement of his father, Dr. P. L. Sclater, F.R.S., last year.

FURTHER particulars of the work and position of the National Antarctic Expedition have been brought by the New Zealand mail, and are published in Wednesday's *Times*. The chief scientific work accomplished by the expedition is summarised as follows:—(1) The discovery of extensive land at the east extremity of the great ice barrier. (2) The discovery that MacMurdo Bay is not a "bay," but a strait, and that Mounts Erebus and Terror form part of a comparatively small island. (3) The discovery of good winter quarters in a high latitude—viz. 77° 50′ S., 166° 42′ E.—with land close by suitable for the erection of the magnetic observatories, &c. The lowest temperature experienced was 92° of frost Fahrenheit. (4) An immense amount of scientific work over twelve months in winter quarters, principally physical and biological. (5) Numerous and extensive sledge journeys in the spring and summer, covering a good many thousand miles, of which the principal is Captain Scott's journey, upon which a latitude of 82° 17′ south was attained, and an immense tract of new land discovered and charted as far as 83° 30′ south, with peaks and ranges of mountains as high as 14,000 feet. (6) The great continental inland ice reached westwards at a considerable distance from the coast and at an altitude of 9000 feet. (7) A considerable amount of magnetic work at sea, also soundings, deep-sea dredging, &c. Commander Scott's narrative of the expedition and statement of scientific observations, telegraphed from Lyttelton, and given in our issue of April 2 (p. 516), is thus confirmed. It was not clear at the time of the cable message why the *Discovery* could not get out of the ice, though the relief vessel, the *Morning*, had done so and returned to New Zealand. It is now known, however, that the *Morning* only got within about eight miles of the *Discovery*, and the stores had to be transferred by means of sledges. As the *Discovery* has not returned to Lyttelton, there is little doubt that the expedition has been forced to spend a third winter in the Antarctic. Much additional expense will thus be incurred, and it is estimated that from 12,000*l*. to 20,000*l*. more will be needed to meet it.

THE death is announced of Mr. C. Bartlett, late superintendent of the Zoological Society.

A UNIVERSAL Exposition of Sciences, Arts, and Industries is to be held at Liége in the year 1905.

THE death is announced of M. de Bussy, member of the Institute of France, and well known as a naval engineer.

AN earthquake shock, lasting five seconds, was felt in villages between Worksworth and Derby on Sunday, May 3, at 9.20 p.m.

ACCORDING to a Central News message from San Francisco, dated May 1, a report from San Juan states that the Santa Maria volcano in Guatemala is in a state of active eruption.

THE Louis Pillet prize of the Chemical Society of Paris has been awarded to M. E. Theulier, director of the technical staff and head of the research laboratory of Messrs. Lautier fils, of Grasse.

AN international exhibition of agriculture and horticulture, which the Cercle grand-ducal d'Agriculture et d'Horticulture du Grand-Duché de Luxemburg is organising at Luxemburg on the occasion of the fiftieth anniversary of its foundation, will be held from August 29 to September 7.

IT is announced in *Science* that the Donohoe comet-medals of the Astronomical Society of the Pacific have been awarded to M. Michel Giacobini, of Nice, for his discoveries of unexpected comets on December 2, 1902, and January 15, 1903.

THE proposed electric railway to the summit of Mont Blanc is to be commenced shortly. The municipal authorities of Saint Gervais-les-Bains have accepted the scheme, and have accorded the concession to the French engineers, MM. Deruad and Duportal.

A NOTEWORTHY point in connection with the illuminations of Paris, organised by the reception committee in honour of the King's visit, was the electric incandescent lamps of different colours in the chief streets and avenues and on many large buildings. The effect was very brilliant, and the large crowd of sightseers admired it exceedingly.

THE council of the Society of Arts is prepared to award, under the terms of the Benjamin Shaw Trust, a prize of a gold medal, or twenty pounds, for the best dust-arresting respirator for use in dusty processes and in dangerous trades. Inventors intending to compete should send in specimens of their inventions not later than December 31 to the secretary of the Society of Arts, John Street, Adelphi, London, W.C.

INVITATION cards in the name of the president of the Institution of Electrical Engineers are being issued to members of the Institution for a concert to be given at the Royal Albert Hall on the evening of Thursday, June 11, on the occasion of the International Telegraph Conference. The annual conversazione of the Institution will be held at the Natural History Museum on the evening of Tuesday, June 23. This date has been selected as one on which it will be possible for the members of the International Telegraph Conference to be present.

ON Tuesday next, May 12, Prof. G. H. Darwin delivers the first of two lectures at the Royal Institution on "The Astronomical Influence of the Tides," and on Thursday, May 14, Prof. S. H. Vines begins a course of two lectures on "Proteid-Digestion in Plants." The Friday evening discourse on May 15 will be delivered by Dr. D. H. Scott on the "Origin of Seed Bearing Plants."

THE new Johnston Laboratory at University College, Liverpool, is to be opened by Mr. Walter Long, M.P., President of the Local Government Board, on Saturday, May 9. Many distinguished men of science have expressed their intention to be present at the ceremony. On Monday, May 11, a conference on tropical sanitation will be held in the college.

THE Manchester Literary and Philosophical Society will shortly celebrate the centenary of Dalton's enunciation of the atomic theory. On May 19 Prof. F. W. Clarke, of the Columbia University, Washington, will deliver a lecture on the evolution and philosophy of the theory. Arrangements are also being made for a conversazione at Owens College, and exhibition of Dalton manuscripts, portraits, and other records.

REUTER reports that if within a short time no ship from the Falkland Islands arrives at Montevideo or Buenos Ayres with news of the Nordenskjöld Antarctic expedition, an expedition to relieve Nordenskjöld will be equipped at Stockholm immediately, and should no intelligence of the explorer have come to hand in the meantime, will leave on September 1 for the South Shetland Islands, where it should arrive about the middle of November. The funds required for the relief expedition have already been secured.

A GREAT rock slide occurred on the morning of April 29 at Frank, a small mining town on the Canadian Pacific Railway in the Rocky Mountains, and in Alberta Territory. A telegram from Sir Wilfrid Laurier states that the whole east end of Turtle Mountain from the mouth of Frank Mine slid into the valley and blocked it entirely. The railway was covered with débris for a mile and a half east of Frank. The landslip gave rise to great clouds of dust, which were at first thought to be due to a volcanic eruption, and was reported as such, but this conclusion was entirely unfounded.

CAPTAIN SVERDRUP gave an account of his expedition to the Arctic region in 1898 to 1902 before the Royal Scottish Geographical Society on Monday night, and was presented with the gold medal of the Society in recognition of his achievements. Sheriff Guthrie, who presided, prefaced the address with an appeal on behalf of the Scottish Antarctic expedition under Mr. W. S. Bruce. The leader hoped to be engaged in his work for two years, and funds for the first year are still short by 2250*l*., while for the whole expedition a sum of 10,000*l*. is wanted.

THE Government of India is endeavouring to bring into being the Tata institution for scientific teaching and research at Bangalore. The *Daily Mail* states that the Government has just addressed the Bombay Administration, offering to increase the grant so as to raise the total annual income of the institute to 15,000*l*., conditionally on the Mysore durbars carrying out its proposal that they should assist. Lord Curzon hopes that Mr. Tata will now expedite his arrangements so as to enable legislation for the constitution of the institute to proceed.

IN the article on standardisation which appeared in NATURE of April 23 (p. 587), it is stated that the work of the Engineering Standards Committee was started two years ago at the suggestion of the Institution of Mechanical Engineers. Mr. Leslie S. Robertson, the secretary of the committee, writes to point out that the committee was formed in pursuance of a resolution of the council of the Institution of *Civil* Engineers. We are glad to make this correction, both for the sake of historical accuracy and because the fact was well known to the writer of the article, who inadvertently named the wrong institution.

M. E. DUPORCQ (Ingénieur des télégraphes), whose death was announced recently (p. 589), was general secretary of the Mathematical Congress at Paris in 1900, and worked hard to make it a success. He was also a vice-secretary of the Mathematical Society of France, and editor of the *Nouvelles Annales*, where most of his mathematical contributions are to be found. These were chiefly in the region of elementary pure mathematics, and he was also a deviser of mathematical problems of the style of Prof. Wolstenholme.

PROF. GEORGE E. HALE has informed *Science* that Miss Helen E. Snow, of Chicago, has provided for the reconstruction of the cœlostat reflecting telescope of the Yerkes Observatory as a memorial to her father. The telescope will be provided with solar and stellar spectrographs, spectroheliographs and other important accessories. The cœlostat reflector which the new telescope is to replace was seriously injured by fire last December, giving rise to erroneous but widespread statements that the main building of the Yerkes Observatory, as well as the 40-inch refractor, had been destroyed.

WE are requested to announce that a representative committee has been formed for the purpose of raising a memorial to the late Sir Henry Bessemer. The remarkable industrial development of the world in recent years is largely due to the metallurgical process which bears the name of Bessemer, and it has long been felt that his life's work should be suitably commemorated in the centre of the British Empire. The objects of the memorial are, first, the erection (and, if necessary, the endowment) of metallurgical teaching and research works in connection with the University of London, equipped for the testing of ores and metallurgical products by modern methods, and for the investigation of new methods and processes; and, second, the foundation of international scholarships for post-graduate courses in practical work in connection with proposals now under the consideration of the Board of Education. The committee is thoroughly representative, and among the men of science upon it are Sir William Abney, K.C.B., F.R.S., Sir John Wolfe Barry, K.C.B., F.R.S., Dr. C. Le Neve Foster, F.R.S., Prof. A. K. Huntingdon, Sir Arthur Rücker, F.R.S., and Sir H. Trueman Wood. A meeting to inaugurate the fund will be held at the Mansion House on Monday, June 29 next, particulars of which will be published later. All communications should be addressed to the secretary, Mr. Charles McDermid, Bessemer Memorial Fund, Salisbury House, London, E.C.

BY the death of Mr. Osler, which occurred on April 26 at his residence, South Bank, Edgbaston, Birmingham, at the age of ninety-five, meteorological science has lost another of its distinguished pioneers. His principal works in this science were contributed to the *Proceedings* of the British Association, and to the *Proceedings* of the Literary and Philosophical Society of Birmingham, between the years 1836 and 1858. He was perhaps best known by his invention of a self-recording direction and pressure anemometer and rain-gauge; one of these instruments was erected at the Philosophical Institute at Birmingham, and a discussion of the observations obtained by it during the years 1839 and 1840 was published in the *Proceedings* of the British Association. Another instrument was erected at the Liverpool Observatory in 1851, and a summary of the records for 1852–5 was published in the latter year. From a report recently received from that observatory, we find that his combined anemometer and rain-gauge is still in use, and continues to give entire satisfaction. In recognition of his researches in this branch of science he was elected a fellow of the Royal Society in 1855. In his earlier years he was actively engaged in the development of the glass industry in Birmingham.

M. PAUL DU CHAILLU, the African explorer and discoverer of the gorilla, died at St. Petersburg on April 30. Paul

Belloni du Chaillu was born in 1835, and at an early age he went to live in the French colony of Senegambia, where his father was a trader. There he acquired a knowledge of languages and modes of life of the tribes, devoting much attention to natural history. At the age of seventeen he went to the United States, where he naturalised himself, but in 1855 he sailed for West Africa again, and spent four years in the interior unaccompanied by any white men, traversing a distance of more than 8000 miles on foot in the equatorial region. The results were embodied in the most important of his works, "Explorations and Adventures in Equatorial Africa" (1861). He returned also with many specimens, some of which were acquired by the British Museum. The work provoked much controversy, and his gorilla and cannibal stories, in particular, were widely discredited; but the general truth of his narrative was afterwards substantiated, both as regards the river systems of the Continent, its equatorial population, and its zoological characteristics. In 1862–65 Du Chaillu revisited West Africa, and afterwards published an account of the expedition in a volume under the title of "A Journey to Ashango-land" (1867). Since then he had made journeys in Sweden, Lapland, and Finland, and written numerous works, the chief being "Stories of the Gorilla Country," "Wild Life under the Equator," "Lost in the Jungle," "The Country of the Dwarfs," "The Land of the Midnight Sun," and "The Age of the Vikings," in which he contended that the origin of the English race was Scandinavian. He was also the author of other works.

REFERRING to Mr. G. Henschel's letter in last week's NATURE (p. 610) on complementary singing by bullfinch and canary, Mr. J. R. Paul writes from Alcluith, Dumbarton, to say that he put a red-pole in a cage hung between the cages of two canaries. After a time the bird dropped the brisk "tweet, tweet" of the finches, and began to imitate the canaries' song. His song is now an almost perfect copy of the canaries' notes, and his own particular note is quite lost. Moreover, Mr. Paul adds that a pair of little green parraquets are also learning the canaries' song. "Within a very few days of their arrival they began to try 'notes,' and already the imitation is laughably correct, the 'squawky,' parrot-like voice making the song only the more ludicrous."

THE first scientific meeting of the Challenger Society for the Promotion of the Study of Oceanic Zoology and Botany was held on April 29, Dr. R. N. Wolfenden in the chair. In a paper on bipolarity, Dr. G. H. Fowler cited recent memoirs to show that, in spite of a good deal of destructive criticism, a *prima facie* case had been made out for a marked similarity (amounting in some instances to specific identity) between the two sub-Polar faunas. Dr. Wolfenden gave a preliminary account of the Copepoda collected by Mr. J. S. Gardiner in the Maldive Archipelago. More than ninety species had been already identified, of which some sixteen were new. Mr. E. W. L. Holt exhibited and made remarks on a new Gnathophausia from deep water. A committee was appointed to inquire whether it will be possible for the Society to undertake a card catalogue for oceanic work.

THE monthly *Bulletin* published by the Philippine Weather Bureau under the direction of the Rev. J. Algué, S.J., contains much valuable information relating to the meteorology and microseismic movements of the Archipelago; the tables include meteorological data deduced from hourly observations made at the Manila Observatory, and rainfall and temperature data at a considerable number of stations. The last *Bulletin* we have received, for November, 1902, gives an account and the track of a typhoon which occurred between November 7 and 12. This typhoon was one of the most rapid that has been experienced, and its speed did not decrease until it reached the Asiatic continent. The map shows that at noon on November 7 it was near the meridian of 135° east, and that twenty-four hours later it had already reached 122° east longitude, and that it entered Luzon during the afternoon of that day. It speaks well for the efficiency of the forecasting department of the observatory that it was able to give timely warning of the approach of the storm to the provinces threatened.

THE Meteorological Office pilot chart for May shows that there are immense quantities of icebergs and field-ice about the Newfoundland banks, so much, indeed, that the steamship owners have been compelled to order their commanders to disregard the international steamer routes, and keep about sixty miles to the southward, so as to endeavour to keep clear of the danger. A number of bergs have been sighted southward of the 41st parallel, beyond the southern point of the Great Bank, and they extend thence northward in vast numbers up the edge of the bank to about the 50th parallel, and no doubt far beyond, while they are scattered as far eastward as the 40th meridian and westward to the 55th meridian. In addition quantities of field-ice, drifting out of the St. Lawrence by Cabot Strait, render navigation in the neighbourhood of Cape Breton and the south of Newfoundland dangerous. It is many years since there was so much ice in the neighbourhood.

NEGOTIATIONS are in progress with the Danish Government for establishing wireless communication to Iceland by the Marconi system. A provisional agreement has been made between the Marconi Co. and a Danish association by which the latter has the option of carrying out the project; it has not yet been decided whether the communication shall be direct between Iceland, the Faröe Islands and Jutland, or between the islands and Scotland.

THE full text of the Government Bill "to facilitate the introduction and use of electrical power on railways," which was read for a first time last month, has now been printed. The chief effect of the Bill is to give the Board of Trade power to make orders authorising railway companies to use electricity as motive power, and to generate such power or make agreements for its supply. There are several other clauses in the Bill relating to provisions which would be necessary in the case of a railway company changing over partly or wholly to electrical working. The Bill, as it facilitates acquiring the necessary powers for electrical working by doing away with the necessity for introducing a private Bill, can only help forward progress in this direction. The Government is certainly to be congratulated on having, for once in a way, recognised the probable developments of science before it is too late, and we hope that the Bill will soon become law, and that the railway companies will avail themselves of its provisions.

SOME interesting evidence was given before the departmental committee on electricity in mines by Mr. Selby Bigge, especially in relation to the position of this country in comparison with America and continental countries. Mr. Bigge stated that he thought this country was very much behindhand, not only in the application of electricity to mining, but in the manufacture of electrical machinery generally. This he attributed partly to the restrictive nature of our legislation, and partly to the lack of scientific training on the part of the managers and others in authority. He instanced numbers of examples of electrical mining in-

stallations on the Continent, laying special stress on the application of three-phase working and the use of high voltages which this system permitted; he even went so far as to say that, paradoxical as he might seem, the higher voltages were probably safer, as the workmen, knowing that any tampering with the mains meant certain death, left them severely alone. For the actual machinery, 500 to 700 volts was a suitable pressure, but 1000 to 3000 volts might be used with advantage for transmission for considerable distances into the mines. Other evidence of an interesting nature was given before the committee, which is still sitting.

OFFICIAL statistics have on several occasions been collected as to the number of horses and other beasts of burden in Italy, but statistics regarding educational matters appear to be few and far between. The only records of the total attendances in Italian schools or colleges under the control of public or religious bodies refer to the year 1870. For private boys' schools results were collected from 1879, and for girls' schools from 1887, but in no case does information extend beyond 1894. Prof. Amato Amati, writing in the Lombardy *Rendiconti*, now asks for an official census of the private schools and educational institutions of Italy.

VARIOUS experimenters have obtained interference between light-waves with a difference of path reaching in one case as much as 790,000 wave-lengths. Profs. Lummer and Gehrcke now describe experiments in the *Verhandlungen* of the German Physical Society, in which interference phenomena were obtained after nine reflections at the surfaces of a uniform plate, representing a difference of path of 2,600,000 wave-lengths, and they draw the conclusion that among the particles of vapour in the mercury arc used as the source of light, the greater portion send out light capable of producing interference for a longer time than the interval (less than 10^{-8} of a second) in which $2\frac{1}{2}$ million waves are emitted.

THE importance of a convenient, accurate, and at the same time readily understood designation of musical notes in connection with the study of audition and partial deafness forms the subject of a paper by Sir W. R. Gowers, F.R.S., in the *Review of Neurology and Psychiatry* for April. At present there is no uniformity of notation, and the notation adopted by Helmholtz was merely an old and inconvenient notation used in organ construction. The present writer proposes to use C to denote the "middle C" (frequency 264), to use C^1, C^2, C^3 to denote the successive octaves *above*, and to use C_1, C_2, C_3 to denote the successive octaves *below* middle C, each octave extending to the B above.

IN describing the brain of the walrus, Mr. P. A. Fish (*Proc.* U.S. Nat. Mus., No. 1325) shows that the general plan of the fissures corresponds to that obtaining in Carnivora generally, and more especially seals.

THE Natural History Branch of the British Museum has received from Lord Crawford a small but interesting series of birds' skins collected by Mr. M. J. Nicholl on St. Paul and Noronha Islands, off the Brazilian coast. The only specimens from the latter island previously in the collection were obtained by Dr. H. N. Ridley in 1886.

IN vol. iii., part iii., of the *Annals* of the S. African Museum, Mr. G. A. Boulenger describes six new forms of perch-like fishes from the Natal coast. Recent issues of the *Proc.* U.S. Nat. Mus. contain papers on the band-fishes (Cepolidæ) and loaches (Cobitidæ) of Japan, by Messrs. Jordan and Fowler.

IN the course of a series of notes on the ornithology of Norfolk for 1902, published in the April number of the *Zoologist*, Mr. J. H. Gurney directs attention to the great migration of rooks and other members of the crow family which took place on the east coast during October of last year. The greater number of the immigrants were rooks, and the movement extended at least as far as Lincolnshire. Several rare birds are recorded as stragglers. Mr. Gurney adds that there is no good news to record of the great bustards which were turned down at Brandon in 1900. Of the original fifteen, only a single pair now remain; the hen laid a couple of eggs, which were incubated for six weeks without a successful result.

WE have received from Prof. W. C. M'Intosh a copy of a pamphlet on British fisheries' investigations and the international scheme. After referring to past and present investigations in connection with British fisheries, the author discusses the international scheme for the systematic biological survey of the North Sea, to which allusion has recently been made in our columns, urging that if the British Government resolves to participate in the scheme, attention should be concentrated on the habits and development of fishes and their food-supplies to the exclusion of subjects connected with hydrography. In regard to the supposed deterioration of our fisheries, Prof. M'Intosh is an optimist, remarking that "There is no fear of the extinction of any species, especially of those important to man. Furthermore, fishes have abounded in the primæval as in the modern seas, although the ravages of the gigantic reptilian and other fish-destroyers—which in some instances were distributed over the whole expanse of the ocean—could not have been less than even the far-reaching efforts of man. In neither period has extinction ensued from the prevailing agencies, nor is it likely to take place under these conditions in the future."

AN account of the structure and properties of a leguminous liane, *Derris uliginosa*, the leaves of which have been used as a fish poison by Fijian islanders, has been received from the Wellcome Research Laboratories. A description of the anatomy of the stem is furnished by Mr. Perrédès, from which it appears that irregular secondary vascular structures arise in the cortex. As a result of chemical investigation, Dr. Power discovered a considerable amount of tannin and various resinous substances. The toxic action is attributed to a constituent of that part of the resin which is soluble in chloroform, and not to the tannin.

THE progress of the German East African colony may be studied in the reports presented by the officers in charge of districts, which are embodied in the *Berichte* issued from Dar-es-Salâm. The native food resources are matama, maize, manioc, and in some parts bananas. Owing to the risks of failure of the three first, the natives have been encouraged to take up the cultivation of rice and sweet potatoes. As a source of revenue extensive plantations of coffee have been started by German companies, and on a smaller scale the cultivation of coco-palms, agave and ceara rubber is being extended with promising results.

OF the papers read before the American Society for Plant Morphology and Physiology, two contributed by Dr. E. F. Smith refer to bacterial diseases attacking Japanese plum trees and sweet corn, in both of which cases the author concludes that infection takes place through the stomata. A paper by Prof. Duggar traces the inconsistency of the osmotic action of certain salts on marine algæ to their toxic action, and potassium salts were found to be more

poisonous than the salts of calcium or magnesium. Prof. Jeffrey outlines an anatomical clue to the phylogeny of the monocotyledons which would derive them from dicotyledons. A suggestive paper by Prof. Toumey discusses the initial root system of tree seedlings.

THE latest addition to the useful series of short scientific memoirs published in Paris by M. C. Naud under the name *Scientia* is by Dr. L. Décombe, and is entitled "La Compressibilité des Gaz Réels." This is the twenty-first volume in the series dealing with physical and mathematical subjects.

THE Cambridge University Press has published the second part of vol. ii. of the "Reports of the Cambridge Anthropological Expedition to Torres Straits," which deals with physiology and psychology. The fasciculus contains sections by Mr. Charles S. Myers on hearing, smell, taste and reaction-times, and by Mr. W. McDougall on cutaneous sensations, muscular sense, and variations of blood-pressure.

THE decision of the Government to continue the present temporary Vaccination Act for one year has met with the approval of conscientious objectors, whose case Mr. Alexander Paul appears to take up in his little book, "The Vaccination Problem in 1903, and the Impracticability of Compulsion," recently published by Messrs. P. S. King and Son. The book should be useful in making clear the position of the objectors, so that the difficulties they put forward can be satisfactorily met when occasion requires it.

THE Orient-Pacific Line have published their pleasure cruise arrangements for the forthcoming Norway season. Three steamers will be employed, viz. the *Orient*, the *Cuzco* and the *Ophir*. The cruises begin on June 11, and vary in length from twenty to twenty-eight days. In addition to the attractions of Norwegian scenery and the Midnight Sun, the programme includes a visit to the glaciers of Spitsbergen with a prospect of seeing the Polar pack.

MR. A. R. HINKS writes in the *Monthly Review* for May on the evidence for life on Mars, and his article is illustrated by two maps of the canals or channels observed by Schiaparelli. The article is largely taken up with an account of Mr. Percival Lowell's observations of Mars at Flagstaff, in Arizona, and the conclusions drawn by Mr. Lowell, following a suggestion of Schiaparelli, as to the existence on Mars of a great irrigation system.

THE report of the council of the Hampstead Scientific Society for the year 1902 shows that the association continues its commendable activity. Among the lectures organised by the Society during the year may be mentioned those of Prof. Boyd Dawkins, F.R.S., on the forest primeval of the Coal-measures; Mrs. Dr. Bryant, on bees as builders of the honeycomb and otherwise; and Dr. Shenton, on medical applications of Röntgen rays. But much of the useful work of the Society is accomplished in sectional meetings, which are held in connection with the astronomical, the natural history, and the photographic sections two or three times a month. The example set by the Hampstead Society might with advantage be more widely copied.

CONSIDERABLE evidence is being accumulated at the present time which is apparently strongly antagonistic to the view that electrically charged ions are the factors which are directly active in all cases of chemical change. In the March number of the *Journal of Physical Chemistry*, Mr. H. E. Patten gives an account of experiments on the interaction of metals and hydrochloric acid in various perfectly anhydrous solvents. The solvents employed were benzene, chloroform, tin and silicon tetrachlorides, phosphorus and arsenic trichlorides, antimony pentachloride, sulphur monochloride, and thionylchloride. These solvents had a smaller conductivity than air, and yet zinc was in all cases directly acted upon by the acid.

AN interesting study of the modifications of acetaldehyde is the subject of a paper by R. Hollmann in the *Zeitschrift für physikalische Chemie*. Experimental data are given which show clearly the relationships existing between acetaldehyde and paraldehyde for temperatures ranging from $-100°$ C. to $300°$ C. Of special interest are the observations relating to the composition of the liquid substance in its natural state of equilibrium. At the melting point ($6·75°$ C.) the liquid consists of 88·3 per cent. of molecules of paraldehyde, whilst at the boiling point ($41·6°$ C.) the molecular proportion is 53·4, and at the critical temperature ($217°$ C.) only 11 per cent.

THE additions to the Zoological Society's Gardens during the past week include a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Mr. H. R. Harger; a Springbok (*Gazella euchore*) from South Africa, two Feline Dourocoulis (*Nyctipithecus vociferans*) from Southern Brazil, two Violet-necked Cassowaries (*Casuarius violicollis*) from the Aru Islands, four White-eared Bulbuls (*Pycnonotus leucotis*), an Indian Python (*Python molurus*), four Saccobranchs (*Saccobranchus fossilis*) from India, three Grey-breasted Bullfinches (*Pyrrhula griseiventris*) from Japan, three Mocassin Snakes (*Tropidonotus fasciatus*) from North America, five Red-spotted Lizards (*Eremias rubropunctata*) from Egypt, a Delalande's Gecko (*Tarentola delalandii*) from West Africa, deposited; a Diamond Snake (*Python spilotes*), three Brush Turkeys (*Talegalla lathami*) from Australia, purchased; an Axis Deer (*Cervus axis*), eight American Timber Wolves (*Canis occidentalis*), two Crab-eating Raccoons (*Procyon cancrivorus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—A telegram received from the Kiel Centralstelle informs us that Mr. Grigg, observing at Mr. Tebbutt's observatory, Windsor, New South Wales, discovered a new comet on April 17. The position of this object at 6h. 44m. 2s. (M.T. Windsor) on April 27 was:—

R.A. = 4h. 3m. 24s.
Dec. = $16° 23' 25''$ south.

The daily movement in R.A. is $+1° 26'$, and in declination $+0° 27'$; the announcement says nothing about the comet's brightness.

The above position is a little s.f. of γ Eridani.

NOVA GEMINORUM.—A telegram received from Prof. E. C. Pickering on April 22, published in No. 3864 of the *Astronomische Nachrichten*, states that "the light of Nova Geminorum is increasing."

THE PARTIAL ECLIPSE OF THE MOON ON APRIL 11.—The most striking feature of this eclipse was the blackness of the eclipsed surface, for it was not possible to see any of the details on that portion of the surface which was covered by the shadow. In a paper published in No. 16 (1903) of the *Comptes rendus*, M. Montangerand describes the results of the attempts he made to photograph that portion of the lunar surface eclipsed by the earth's shadow.

Using the astrographic-chart telescope and Lumière plates, and giving an exposure of one second to each plate, he obtained eleven negatives, two of which, Nos. vii. (Lumière "blue") and ix. (Lumière panchromatic), show the contour of the eclipsed moon, but no surface details.

The visual observations corroborate the photographs in showing that at this eclipse the shadow was especially black, so that no details of the eclipsed surface could either be seen or photographed. This result differs greatly from that recorded for the eclipses of December, 1898, and December, 1899, when the eclipsed surface was plainly visible and of a marked ruddy colour.

THE OCCURRENCE OF SPARK LINES IN ARC SPECTRA.—In a paper which recently appeared in the *Sitzungsberichte der K. Akademie zu Berlin* (January 22), Messrs. J. Hartmann and G. Eberhard give the results of a number of experiments they have made in order to determine under what conditions various lines, usually associated with spark spectra, may appear in the spectrum of the arc.

In the cases of magnesium and silicon—which are so important when considering stellar spectra—the authors found that when the arc was produced under water, using metallic poles, the magnesium line at λ 4481 and the silicon lines at $\lambda\lambda$ 4128 and 4131 were produced, although all three are usually called "spark" lines. In the case of zinc, the "spark" lines at $\lambda\lambda$ 4912 and 4925 were obtained under similar conditions.

The authors have also photographed the spectra of these metals when the arc was enclosed in an atmosphere of hydrogen, and again, under these conditions, the "spark" lines appeared. From this similarity of the results Messrs. Hartmann and Eberhard arrive at the conclusion that, when the arc is struck under water, it immediately becomes surrounded by an atmosphere of hydrogen, produced by the decomposition of the water, and so the same results under the two different primary conditions are obtained (*Astronomische Nachrichten,* No. 3858).

FOUR STARS WITH VARIABLE RADIAL VELOCITIES.—In *Bulletin* No. 31 of the Lick Observatory, Mr. H. M. Reese announces the discovery of four more stars having variable velocities in the line of sight; they are as follows:—

υ Andromedae.—Plates secured on October 8 and November 5, 1902, and January 14, 1903, show velocities of −17 km., −76 km., and +49 km. respectively. The spectrum shows few lines, and the hydrogen lines are broad, but the helium lines are fine and easily measurable.

π^4 Orionis.—The plates obtained on October 6, 1902, January 4 and January 12, 1903, indicate velocities of +43 km., ±0 km., and +6 km. respectively, the spectrum being similar to υ Andromedæ.

σ Geminorum.—Velocities of +74 km., +12 km., +9 km. and +69 km. are indicated by negatives obtained on March 16, 1902, January 12, 13, and February 15, 1903, respectively. The lines, though numerous, are rather hazy, but they give trustworthy results.

ι Argus.—The variable velocity of this star was discovered by Prof. Campbell from the comparison of a plate obtained on February 21, 1898, with previous measures. A series of seven photographs obtained between February 23, 1897, and February 18, 1902, shows a range of velocity from +41·9 km. to +50·3 km.

The photographs mentioned above have been obtained with the Mills spectrograph, and measured by Messrs. Reese and Curtis. Mr. Reese also announces that the star ϕ^2 Orionis is an especially interesting object on account of its great radial velocity, plates obtained on October 28, November 24, and December 30, 1902, indicating velocities of +94 km., +102 km., and +96 km. respectively. The range of 8 km. may not be taken as indicating a variable velocity for this star, for although the photographs show fairly good lines, the second one—in which the variation appears—was very much under-exposed.

THE HARVARD MERIDIAN PHOTOMETER OBSERVATIONS.—Part ii. vol. xliv. of the Harvard College Observatory *Annals* is devoted to a description of the reduction of the observations made with the meridian photometer during the years 1892–98. The editor, Prof. E. C. Pickering, gives a detailed description of the meridian photometer and the methods pursued in making the observations. This description is followed by tables giving the results of the observations of Harvard photometer and A.G. catalogue stars made during the period named above, each table being followed by voluminous notes as to the peculiarities of the observed objects and the observing conditions.

ENGINEERING EDUCATION ABROAD.

THE conditions governing the competition among the great manufacturing countries for the markets of the world have, during the last thirty years, undergone profound modification. At the beginning of the latter half of last century British manufacturers held an unique position which secured for them what was practically the monopoly in some departments of the world's trade. The reasons for this fortunate position are too well known to require elaborate recapitulation. It is enough to remember that while other countries were on one hand engaged in war and on the other in maturing a stable and enduring constitution, Britain was establishing flourishing manufacturing centres, which, with the assistance of her possession of coal and iron, supplemented as it was by the natural endowments of her citizens so far as perseverance and inventiveness were concerned, resulted in her becoming the world's workshop. In no direction was this supremacy more pronounced than in the several branches of the engineering trades. But since then great changes have taken place. By carefully laid plans and persistent effort, other countries have succeeded in overcoming their disadvantages, and as a result of the provisions they have made for the education of their young men in scientific technology, the British manufacturer has now to reckon with formidable German and American competitors.

The changed conditions have been made the subject of study by several authorities in this country, one of the most recent being Prof. W. E. Dalby, who has studied the question of the education provided for engineers in America, Germany and Switzerland. The opportunity which his commission from Mr. Yarrow to report on the training of engineers in other countries has given Prof. Dalby make the recent papers read by him before the Institution of Naval Engineers and the Institution of Mechanical Engineers of exceptional value, and it is much to be hoped that the following facts from his papers, and the lessons to be drawn from them, may have a good effect in convincing our manufacturers and educational authorities that the higher education of those engaged in industrial pursuits has a direct and immediate effect on success in the struggle for commercial supremacy.

The paper read before the Institution of Naval Architects was concerned only with the education of engineers in the United States; that before the Institution of Mechanical Engineers included a study of the question in Germany and Switzerland also. It will be most convenient to take these countries in order. Beginning with the United States, the nature of the technical education in the best colleges may first be considered, and then the relation between the employers and the technically trained men graduating from these colleges.

America.—A good idea of the aims of the technical colleges of America may be gathered from the words of one of the chief founders of the Massachusetts Institute of Technology of Boston, who laid it down that the most truly practical education, even in an industrial point of view, is one founded in the thorough knowledge of scientific principles, which unites with habits of close observation and exact reasoning a large general cultivation. The highest grade of scientific culture is not too high a preparation for the labours of the mechanic and manufacturer, and there are in the history of social progress ample proofs that the abstract studies and researches of the philosopher are often the most beneficent sources of practical discovery and improvement.

Inspired by such enlightened views of technical education, it is not surprising that there has been a steady increase in the number of engineering students in the chief American colleges. The first table on p. 18 gives an idea of the growth of their engineering departments.

At Cornell University students of mechanical engineering and the allied branches do their work at Sibley College; there is a separate building for civil engineering and architecture. Sibley College is divided into eight departments, viz. mechanical engineering, mechanical laboratory instruction, electrical engineering, mechanic arts (workshops), industrial drawing and art, machine design, graduate schools of marine engineering, and the graduate school of railway mechanical engineering.

Showing Numbers of Students in Engineering in Certain Colleges.

	YALE. Civil, Mechanical, Electrical, Mining and Sanitary Eng. Students in the Sheffield Scientific School.	CORNELL. Civil, Mechanical and Electrical Students.	MASS. INST. Civil, Mechanical, Electrical and Mining Students.
1895–96	209	617	357
1896–97	174	623	352
1897–98	153	645	356
1898–99	166	686	347
1899–00	162	774	356
1900–01	163	844	372

The staff consists of thirty-six teachers and instructors, and this number includes six professors and four assistant professors, and eight non-resident lecturers. The staff is inadequate at the present to deal with the numbers of students in the college.

A great feature of this institution is its workshops. Here instruction is given in pattern-making, moulding, forging, fitting and turning, and the work done in them is real. All students in the college pass through the same course during the first three years. They may specialise in the fourth year in steam, marine, railway or electrical engineering with specialists in those subjects.

Admission to the course in the American college is by examination. To enter Cornell a student must be sixteen years of age, and to enter the Massachusetts Institute seventeen. The standard of examination is such that a youth from a good high school can pass. There is no freedom left to the student regarding his course of studies when once he has chosen his department. Examinations are frequent, and promotion from one year to another depends upon the result of them. The courses are really a carefully-thought-out and elaborately organised species of educational drill. As a general rule a man must go through with it or fall out.

At the Massachusetts Institute the courses are so arranged that a student can do his work in forty-eight hours per week. Half of this time is given to lectures, &c., at the college, the other half is assumed to be spent in private study. The same method appears to be in operation at Cornell, Harvard and Yale. An analysis of the courses shows what is understood by a technical education in the States; it is really four years of continuous hard work at a college equipped with engineering laboratories and workshops, and with all the educational apparatus for giving a scientific education.

It is interesting to note the attitude of employers in the United States to the men who study in the way just described in these American colleges. A point in which American practice is remarkably different from ours is that age is no limit to a man who wants to get practical work in the shops, providing he is a college graduate. Employers might not take on an apprentice after twenty-one years of age if he were not a graduate. College graduates in America never find that, whilst learning the scientific principles of their profession, they have grown too old to enter the workshops to learn the practical part. The general opinion seems to be that the educated man picks up his practice much quicker and more intelligently than the younger man with only an ordinary education. Generally speaking, the attitude of the American employer towards these graduates is one of distinct encouragement, and of advantage to both. The employer gets the advantage of a trained intellect, the employee gets the advantage of his employer's shops and business experience. The American employer keeps an "open door" for the technically trained man, whilst with us in England the door is too often closed by rules regarding age and the like, and the would-be apprentice not having sufficient means to pay a premium in addition to the amount he has already paid for his education. In cases where college graduates are taken on in England, they are, as a rule, expected to go through the same course in the shops as a boy entering straight from school. The Americans are more yielding in this respect, and do not insist upon the drudgery of the first few years.

Germany.—The Berlin Technical High School at Charlottenburg is a State institution, and its object is to give a specialised training in industrial subjects founded on a preliminary scientific education. The course, lasting four years, begins with scientific subjects, and gradually becomes more technical until in the fourth year all the subjects are specialised. German subjects are admitted to the school on the production of a "maturity certificate" from a German gymnasium or a Prussian real-gymnasium. The education given at the two kinds of schools corresponds very roughly with that given in the classical and modern courses of our public schools. The maturity certificate is obtained at the end of a nine years' course. Those admitted by means of this certificate are styled *Students*.

Persons who cannot obtain or have not obtained this certificate can be admitted on school certificates of a lower value, but for the departments of architecture, civil and mechanical engineering and naval architecture must in addition show that they have worked for at least one year in some works. Those entering in this way are styled *Hospitanten*. The school has recently been given the status of a university.

As an instructive indication of the importance attached to higher technical education in Germany, the tables which have been drawn up by Prof. Dalby showing the numbers of students and teachers at the Charlottenburg institution may be given:—

Students of Various Grades in Attendance for the Winter Half-Year, 1902–3.

	Students.	Hospitanten.	Total.
1. Architecture	477	262	739
2. Civil Engineering	647	42	689
3. Mechanical Engineering:			
Specialising in Mechanical Engineering	1319	180	1499
Specialising in Electrical Engineering	270	51	321
4. Naval Architecture:			
Specialising in Naval Architecture	241	18	259
Specialising in Marine Engineering	106	17	123
5. Chemistry and Metallurgy:			
Specialising in Chemistry	161	20	181
" " Metallurgy	169	11	180
6. General Science	6	—	6
Persons admitted under special regulations from affiliated Institutions	—	—	80
Officers and Engineers from the Navy	—	—	301
Total	3396	601	4378

Teaching Staff.

	Architecture.	Civil Engineering.	Mechanical Engineering.	Naval Architecture.	Chemistry.	Science.
Professors	18	14	20	6	13	18
Priv. Docenten	17	8	8	1	17	15
Construction Engineers	—	—	7	2	—	—
Lecturers	—	—	—	—	—	2
Assistants	1	1	13	3	15	4
Honorary Assistants	53	33	67	9	10	27
Total	89	56	115	21	55	66

Expressed briefly, there are 4378 students of all kinds and 402 members of the teaching staff.

A distinguishing characteristic of the Berlin Technical High School is the right maintained by the students to choose their own courses of study. This freedom is common to German universities, and it follows that the educational authorities can only suggest courses of study, leaving the students free to follow their suggestions completely, or partially, or not at all. Nevertheless, very complete and elaborate courses have been arranged, and as a rule are followed by the students.

There is no attempt to teach workshop practice. Laboratory teaching is confined to the engine laboratory and the electrical laboratory, with a little practice in testing materials at the neighbouring Government testing establishment (Königliche mechanische-technische Versuchanstalt).

The most striking feature of the course is the relatively large amount of time devoted to machine construction, including machine drawing, graphic statics, descriptive geometry, and the lectures connected with the various forms of machines, in which exercises in the drawing office are given. Prof. Riedler, who is at the head of this department, carries on a large engineering practice in the building, employing between twenty and thirty draughtsmen. The majority of these men take part in teaching the subject, so that mechanical drawing and machine design are taught by practical draughtsmen engaged for the greater part of their time in actual designing. No better method than this could be devised, because to all intents and purposes the students are working under actual drawing-office conditions.

A student passing through this course has a large amount of drawing-office practice of an advanced character, but very little practical work. Whether this kind of training is the best is a matter of opinion, but Prof. Dalby thinks a course which makes less claim on the students' time for college work and allows more for practical work would, on the average, in the long run produce better engineers.

Switzerland.—The Polytechnic at Zurich is a State institution designed to give a specialised training in industrial subjects. The course lasts four years. Students are admitted by examination at eighteen years of age. A "maturity certificate" from a Swiss school is taken in lieu of an examination, or a student may be excused part of the entrance examination by presenting certain school certificates. During 1901–2, there were 181 Swiss students of civil engineering, 230 studying mechanical engineering, and 49 taking up architecture, and in addition 249 foreigners in the same departments.

The lectures and exercises as announced in the programme of the several departments are obligatory on the student. In each department, however, the students are allowed a choice in the third year. Once having chosen, they are obliged to follow the plan selected. As at Berlin, no attempt is made to teach workshop practice, but the bulk of the time is given to drawing-office work.

General Remarks.—In all the courses described, a common scientific basis in the first two years develops into widely divergent and specialised branches in the remainder of the course. It should be understood that both in the States and on the Continent many of the specialised lectures are given by men in the full practice of their profession, and who are not regular members of the teaching staff. The best courses in this country are arranged on practically the same basis, but the longest being three years, there is no time to develop the instruction into the specialised branches of engineering.

There is an essential difference in the method of training in America and Germany. In America the course of instruction is very exactly laid down, and the student is compelled to follow it step by step. Slight variations are permitted in the form of options, to use their term, in the later periods of the course. The student gets his degree from the gradually accumulating results of terminal and sessional examinations, ending finally with a thesis.

In Germany the students of their great technical high schools enjoy the freedom peculiar to the university system of that country. No student is compelled to take any special course. For his convenience definite courses are arranged and laid down in the school calendar, but the sequence of lectures therein stated is not binding. The courses are only recommendations, and students may follow them or not as they please. At Zurich the course is partly prescribed, partly selected.

The following table gives a good idea of the nature of the engineering courses in the three countries, the subjects studied, and the relative importance attached to each.

The Percentage Number of Hours' Instruction given in Various Mechanical Engineering Courses.

	Massachusetts Institute.	Cornell.	Berlin Technical High School.	Zurich Polytechnic.
Mathematics	8	5	14·5	19·2
Physics	5	8	6·8	6·0
Chemistry	7	7	1·7	3·0
Applied Mechanics	7	10[1]	22·5	19·5
Mechanism	4	—	8·0	—
Steam-Engine, including Thermodynamics	6	6	4·1	8·0
Mechanical Drawing[2]	26	20	31·0	39·3
Electrical Engineering	2	2	3·4	5·0
Commercial Subjects	2	—	8·0	—
Workshops	14	30	Nil	Nil
French	6	—	"	"
German	3	3	"	"
English	5	—	"	"
Engineering Laboratories	5	9	[3]	[3]
	100	100	100·0	100·0
Approximate Hours	3000	3000	4000	4000
Distributed over	Four Years.	Four Years.	Three Years.	Three Years.

The fourth year of the continental courses is not included, because it is so cut up with examination work. It must not be forgotten, however, that an American student actually receives 3000 hours' instruction; a German or Swiss student is only recommended to attend courses aggregating 4000 hours. Actually he may work just as many hours as he chooses. In brief, the American courses are more practical in character, they include more laboratory training than is recommended in the German course, and devote a large proportion of the course to the teaching of handicraft skill. In Charlottenburg and Zurich no attempt is made to teach handicraft skill, and the bulk of the training is given in the drawing-office, though in addition a considerable amount of time may be given to engine testing.

One thing is certain, the American, German, and Swiss student starts his course with a far better education on which to build than is the case with us. Much time is wasted at colleges here on teaching things which should have been taught at school. Prof. Dalby believes that the great defect of the British system of training engineers is the want of coordination between the colleges and the employers. If the employers will concern themselves with the question, he feels sure their attitude will speedily change.

The general opinion seemed to be that a course arranged so that the winter months are spent at college and the summer months in the works is a desirable one, and one from which good results may be expected. Such an arrangement obviously cannot be worked without the cooperation of the employers. This alternating system must not be regarded as experimental. Our Admiralty have had something very similar in operation for forty years, and the system has produced a famous roll of chief constructors. The Scottish universities lend themselves to the system, and Glasgow students in engineering consistently study in the winter and work in the summer.

[1] Includes Mechanism.
[2] Includes Freehand, Machine Drawing and the lectures connected with Machine Design.
[3] Laboratory courses are taken in addition, but it is difficult to estimate how much is recommended.

AMERICAN SYMBOLISM.

IN 1899 Mrs. Morris K. Jesup generously provided the means for a study of the Arapaho Indians, and Dr. Alfred L. Kroeber was entrusted with the work; his general description of the Arapaho and of their decorative art and symbolism recently published in the *Bulletin* of the American Museum of Natural History (vol. xviii. pp. 1–150, 1902) proves how well he acquitted himself of his task. Dr. Kroeber now has charge of the anthropological department of the University of California, and we may expect much good work from him in the future in this new field.

The Arapaho are typical Plains Indians, and belong to the linguistic stock of the western Algonkins. The fullest and most accurate account of these people has been given by Mr. James Mooney ("Ghost-Dance Religion," *Fourteenth Ann. Rept. Bureau Ethnol.*), and the sketch of their social organisation and life given by Dr. Kroeber is instructive, and to some extent supplements the previous descriptions.

The main value of Dr. Kroeber's memoir consists in the careful analysis of the meaning of a very large number of designs that ornament objects in every-day use, and in the wealth of the accompanying illustrations. The conscientious labour which this implies is deserving of the thanks of fellow-students of decorative art and symbolism.

There is a good deal of latitude in the interpretation of decorative designs employed by different individuals: usually an Indian refuses to interpret the ornamentation on an article belonging to someone else, giving as a reason that he does not know what that particular artist intended to represent. For example, the rhomboid or diamond-shaped symbol may signify the navel, a person, an eye, a lake, a star, life or abundance, a turtle, a buffalo-wallow, a hill or the interior of a tent. All except the first of these significations have also been found attached to very different symbols; thus, a person is also denoted by a small rectangle, a triangle or a square, by a cross, a dot or a line, as well as by rudely realistic designs. A lake may be represented by a square, a trapezoid, a triangle, a pentagon, a circle or other figures. The decorative symbolism is not intended as a means of communication, hence there is no fixed system of symbolism. One person thinks about the significance of his designs, while another considers chiefly their appearance. The former may have two or three interpretations for one symbol or design which are appropriate and coherent; the symbols of the latter will have their most conventional meaning, without much relation to a thought-out scheme. In either case, the Indian never dreams of making a picture that can be recognised by everyone at first sight. These peculiarities can be paralleled in other parts of North America, and, indeed, elsewhere.

A pictograph serves as a means of record or communication, and is normally not decorative; while this art is too decorative to allow of its being read in the same way; yet there is considerable similarity in the symbols used in both systems. Moreover, the significance of a piece of decoration is at times as extended and coherent as that of a pictograph.

Dr. Kroeber insists that the closeness of connection between this decorative symbolism and the religious life of the Indians cannot well be overestimated by a white man. All symbolism, even when decorative and unconnected with any ceremony, tends to be to the Indian a matter of a serious and religious nature. A. C. H.

THE ORIGIN OF NATURAL GAS AND PETROLEUM.

THE volcanic origin of natural gas and petroleum is strongly advocated by Mr. Eugene Coste in a paper read before the Canadian Mining Institute (March 5). The author points to the complete analogy of the products of the oil and gas fields with the products of volcanic solfataric action. These products are water, chloride salts, sulphur, sulphuretted hydrogen, carbonic acid and hydrocarbons. He brings forward facts upon which he bases his view that all the petroleum, natural gas, and bituminous fields or deposits are essentially the products of solfataric volcanic emanations, condensed and held in their passage upward in the porous tanks (sands, limestones, &c.) of all ages from the Archæan to the Quaternary. He instances the occurrence of carbon and hydrocarbons in gneisses and various ancient plutonic rocks. He likewise refers to the dolerite of the Lothians (described by Mr. H. M. Cadell), in which cavities of the rock are filled with a mineral wax not unlike the ozocerite of Galicia. The oil shales through which the igneous rocks have intruded were in Mr. Coste's opinion impregnated by solfataric emanations, for their bituminous character is local, and in proximity to the igneous rocks. Allusion is made to the occurrence of asphalts and oils along the faulted and broken margins of the Gulf of Mexico and Caribbean Sea, the great asphalt deposit of Trinidad filling the crater of an extinct volcano. Again, natural gas and petroleum are associated with mud volcanoes. The author therefore concludes that carbon and hydrocarbons are derived from deep-seated fluid magmas, in which they exist probably in the form of carbides. The "rock pressure" of natural gas is regarded as a remnant of the initial volcanic energy. This has been registered as high as 1525 lb. to the square inch, but is usually between 200 and 1000 lb., and is a constantly decreasing pressure from the time the gas is first used. The theory that artesian water is the cause of the gas pressure is regarded as untenable.

The author points out how generally the diversified "oil phenomena," which include gypsum, sulphur, dolomite, and salt, are met with in American and other oil and gas fields. Disturbed strata and planes of faulting gave access to volcanic emanations which brought up the various products; the rocks were variously impregnated according to the geological and physical conditions of the strata, and the products were sealed up when impervious unbroken strata remained above. In Galicia solid petroleum or ozocerite exists in veins cutting the strata in every direction, the most important being faults. Elsewhere oil occurs in the fractured strata, and such an elusive fluid, pent up under pressure, could not be in its original home. The local and seemingly accidental occurrence of the oil and gas, and even of bituminous shales, are considered by the author to favour his theory, for he observes that the sedimentary strata could not produce from a limited fossiliferous area the quantity of products. Thus, near Baku, in Russia, a small area of not more than eight square miles has now yielded more than 900 million barrels of oil. H. B. W.

SMITHSONIAN REPORT ON SCIENTIFIC WORK.

DR. S. P. LANGLEY, secretary of the Smithsonian Institution, has issued his report on the operations of the Institution during the year ending June 30, 1902, including the work in the United States National Museum, the Bureau of American Ethnology, the International Exchanges, the National Zoological Park, and the Astrophysical Observatory.

Following the precedent of several years, there is given, in the body of the report, a general account of the affairs of the Institution and its bureaus, while an appendix presents more detailed statements by the persons in direct charge of the different branches of the work. Independently of this, the operations of the National Museum are fully treated in a separate volume of the Smithsonian Report, and the Report of the Bureau of American Ethnology constitutes a volume prepared under the supervision of the director of that Bureau.

The following extracts from the report will show that a vast amount of scientific work is being instituted and carried on under the auspices of the Institution.

Hodgkins Fund.—In connection with the administration of the Hodgkins fund, papers recording the advance of specialists along various interesting lines of investigation have been submitted, some of which are now in course of publication.

The report of the research on the spectrum conducted by Dr. Victor Schumann, of Leipzig, has received extensive additions during the year, notably through a detailed description of the ingenious apparatus used in his work. A second grant on behalf of Dr. Schumann has been approved during the year, and it is interesting to know that

Harvard University, recognising the value of his work, has also awarded him a grant. The new Physical Institute of the Royal Academy of Sciences in Leipzig has likewise aided this research by placing laboratory room at the disposal of Dr. Schumann, who, it is hoped, will be able in the near future to secure still more complete results from his painstaking experiments in vacuum spectroscopy.

The memoir by Dr. Carl Barus, issued as part of vol. xxix., Smithsonian Contributions to Knowledge, describes experiments with ionised air, begun by Dr. Barus some years since, and recently prosecuted under a Hodgkins grant from the Institution. The research was tributary to an investigation of the colours of cloudy condensation. Lord Rayleigh's famous theory, if applied, would stop at the deep reds of the first order, terminating in opaque, whereas in the laboratory experiments exceptionally brilliant colours, extending almost into the third order of Newton's series, may be produced. It was thus essential as a preliminary step to investigate appropriate means for the production of nuclei, to determine their number per cubic centimetre, their velocity, their association with ionisation, the effect of the pressure of an electric field, &c. This was the general trend of the experiments by Dr. Barus. The endeavour was made with the aid of the condensation tube to show that the nucleus has a specific velocity of its own, and that this is retained even in the absence of an electric field. The application of this principle to plate, to tubular, and to spherical condensers leads, in every case and in spite of the variation of method, to an order of values as to the number of particles in action, agreeing with the data obtained by other investigators from different experiments and theoretically different points of view. A second grant has been approved on behalf of Dr. Barus, and a new memoir on the structure of the nucleus, detailing experiments subsequent to those described in the volume just published, is soon to be submitted by him.

The experiments in air resistance by Mr. C. Canovetti, which were begun at Brescia, Italy, have been continued, and by means of an ingenious apparatus he has prosecuted a research which has been reported upon in detail, with illustrations accompanied by tables giving the numerical results attained.

Dr. von Lendenfeld, of the University of Prague, who has been assisted by a grant from the Hodgkins fund, reports that his studies are now sufficiently advanced to enable him to begin the preparation of his manuscript for publication. Telephotography has been extensively and successfully used in this research, and the summary of work already submitted is accompanied by interesting illustrations. A monograph embodying the results of the completed research, which will be published later, will present an anatomical and physiological study of insects, the lower vertebrates (Exocœtus, Draco, &c.), birds, mammals (Petaurus, Geleopithecus, &c.), and will treat of the polygenetic development of the organs of flight in animals. The physical properties of the air, wind velocities, resistance, &c., will be considered, and it is hoped that the publication will not only prove of general interest, but will become a valuable work of reference for students.

The research into the nature of vowels by Prof. Louis Bevier, of Rutgers College, has been reported on through a series of published articles, transmitted by the author to the Institution, which record in detail the results thus far obtained. The investigation is still in progress, the vowel series from "a" to "u" being now under analysis and discussion.

A grant has been approved on behalf of Mr. E. C. Huffaker for the construction and practical application of a device intended to produce a uniform and measured flow of air through a tube of any desired diameter. This apparatus is primarily designed for use in connection with investigations in the line of biology, and it has already been applied to exact experiments in the development of the embryo in the egg. It is hoped that by means of this invention facts may be established which will prove of practical value.

The meteorological investigations in connection with air currents at varying altitudes, heretofore reported on as conducted by Mr. A. L. Rotch at Blue Hill Meteorological Observatory, have been supplemented this year by a series of experiments on the lift and drift of the wind on plane and curved surfaces.

Dr. Morris W. Travers, of University College, London, has received a grant, and is now engaged in an investigation which will deal largely with the liquid properties of hydrogen.

National Museum.—This museum, established in the fundamental Act creating the Smithsonian Institution, grew up largely from its private collections, but it is important to consider that now it has grown into something which represents more nearly the large purpose of Congress in its foundation and that it is becoming a "National" Museum. It differs from most other museums in that its primary function was held to be not so much the entertainment or instruction of the resident population as the preservation and arrangement of the collections brought together by the Government of the United States. These collections now outnumber by some millions of specimens those which it has been possible to place upon exhibition in the present inadequate quarters. The number of specimens received during the year was about 450,000, making the total number of objects nearly five and a half millions.

Bureau of American Ethnology.—The work of this Bureau has related largely to a study of the origin, physical and mental characteristics, arts and industries, food supply, social and political institutions, religions, and languages of native American tribes.

Field work was conducted in Alaska, Arizona, California, and in several other States and Territories, as also in British Columbia, Mexico, Greenland, and in Porto Rico, while useful information and material was obtained from correspondents and special collaborators. Special attention was devoted to a study of those aboriginal industries which appeared to bear practical relations to modern life, particularly to aboriginal methods of house building and irrigation, and to food sources in those tropical and arid regions that formerly sustained a population five to ten times larger than at the present day. A noteworthy investigation of aboriginal industries was conducted in Porto Rico, and a special report of the native resources of that island is in preparation.

A special study was made of a ceremony among the Pawnee Indians embracing songs of interest in the development of music and poetry, and to early phases of the drama, the memoir being accompanied by the primitive music recorded by the aid of the graphophone, and with photographs of movements and objects introduced in the ceremony.

International Exchanges.—During the last fiscal year there was handled 125,796 packages, the packages sent abroad numbering 87,149, and those received from foreign countries 38,647. The number of parcels exchanged with Germany was 20,679, and with Great Britain 19,912. France comes next with 11,378, and then Mexico, Italy, Austria-Hungary, and Russia.

It has long seemed desirable to establish more adequate exchange relations with Japan and China, but efforts in that direction have so far been without success. In Great Britain, Germany, and Austria-Hungary, it is still necessary to employ salaried agents to carry on the work, the Governments of these countries for various reasons not yet having organised international exchange bureaus.

Five years ago, in 1897, the total number of correspondents or participants in the exchange service was 28,008, while the aggregate has now reached 38,200 addresses of libraries and individuals in 154 countries scattered all over the civilised world, even in some of the remotest corners of India, Asia, Australia, and Polynesia.

The general benefit of the service to the scientific world can hardly be measured. Largely as a result of these international exchanges there has accumulated in the Library of U.S. Congress a mass of scientific and Government publications that is probably not surpassed anywhere, and could scarcely have been secured in any other way.

National Zoological Park.—Dr. Langley has in previous years called the attention of the Regents to the want of a grant for collecting and preserving some of the great land and marine specimens of the Western territory now rapidly approaching extinction, and he again urges the immediate need of doing something, even on the smallest scale, before it is entirely too late. It is hoped that means will be provided to meet these wants by the establishment of at least

two small stations or ranches in Alaska, one in the interior, where may be secured specimens of the great moose, the great bear, and other disappearing animals of the land fauna; the other "ranch" to be on the coast for the collection of the walrus, the sea otter, the great sea lion of Steller, and other important vanishing marine species.

The animals in the National Zoological Park at the close of the fiscal year included 506 mammals, 232 birds, and 145 reptiles. The accessions of the year numbered 314. More than half of these accessions were gifts to the Government, several of the most interesting animals having been secured through the cooperation of United States consuls and other officials. A fine specimen of grizzly bear, also some antelope, deer, elk, and cinnamon bears were received from the Yellowstone National Park.

The native game, formerly everywhere plentiful, has grown so nearly inaccessible that only after years of effort have there at last been procured a single young male specimen of the great Kodiak bear and two big horn or Rocky Mountain sheep.

The Astrophysical Observatory:—The principal work of the Astrophysical Observatory during the past year has continued to be the study of the sun and its radiation. While fully acknowledging the interesting nature of astrophysical investigation of the stars and nebulæ, the study of the sun has a far superior practical importance, for were the former bodies to be wholly blotted out, they would be missed chiefly as objects of scientific interest, while with the sun would be abolished life itself. The solar researches have mainly been concerned with determining the amount and nature of the absorption of solar radiation in the earth's atmosphere and in the solar envelope. These researches are preliminary to, and form an essential part of, the measurement of the total radiation of the sun. A presumption exists, almost amounting to certainty, that the total radiation of the sun is variable in some relation to the appearance of sun-spots, but nothing is yet known to fix definitely the amount of this supposed variability or to measure its effect upon the earth, though that effect, if so fixed, cannot but be of interest to every inhabitant of the earth's surface.

The instrumental means, which thus have been the subject of incessant study and improvement here during the past ten years, for investigating such questions, are more efficient than at any previous time. The detailed report shows that automatic bolometric curves accurately representative of the amount and distribution of the solar energy at the observer's station may now be obtained in a few minutes, covering nearly the whole spectral region which reaches sea level, and where occurs much of the great and varying absorption by water vapour which influences our terrestrial temperatures so greatly.

Some twenty years ago, when Dr. Langley invented his "bolometer," the instrument was able to measure temperature to about one one-hundred-thousandth of a degree. Since then, during fifteen years of constant advance, latterly associated with a great improvement of the adjuncts, particularly of the galvanometer, at the hands of Mr. C. G. Abbot, this has been brought to measure somewhat less than one-hundred-millionth of a degree, and this almost infinitesimal amount is distinguished with readiness and precision. It is this increased precision which is associated with all the improvements in the work of the year here described.

It is the variability of the absorption of our air which now offers the greatest difficulty to the work. Dr. Langley cherishes the hope that a solar observatory will one day be established high in a clear and dry air, the chief aim of which shall be to solve the questions of the amount of radiation of the sun, the changes in this total amount, and the consequences of such changes on the earth.

The interest of this solar study is peculiar among all the subjects of astronomical research, for it is not only a scientific but a utilitarian interest of such high importance that it has among its remote possibilities the forecasting of the coming seasons and harvests, and of conditions immediately practical, from those which affect the price of the labourer's dinner up to those which, to use the weighty words of Prof. Newcomb, may bring to light not merely interesting cosmical processes, but "cosmical processes pregnant with the destiny of our race."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The General Board of Studies report that in their opinion it is expedient to reestablish the chair of surgery, which has been suspended since Sir George Humphry's death. They propose a stipend of 600*l.* a year, with freedom to undertake private practice, and the right to be *ex officio* surgeon to the hospital and to hold a college fellowship.

A special syndicate has been appointed to consider arrangements for the future conduct of the engineering department, in view of the approaching departure of Prof. Ewing. A bust of the late Dr. John Hopkinson has been presented to the Hopkinson Laboratory, and will be unveiled during the present term.

THE second reading of the London Education Bill was carried in the House of Commons on April 29 by 300 votes to 163.

AT a meeting of the Court of Governors of University College, Liverpool, held on May 2, the chairman alluded to the endowment of a chair of electrotechnics, for which special purpose a donation of 10,000*l.* had been made by Mr. Jardine, and stated that they hoped to receive other special donations in order to establish professorships of applied mechanics and applied mathematics. A new building for electrotechnics and biology is to be erected, which it is hoped will be one of the most perfect of the kind in the country. It was also announced that, assuming all went well, and that the charter constituting the Liverpool University College a separate university was granted in June or early in July, the necessary Act of Parliament would probably be passed during the present session.

THE annual conference of the presidents, deans and executive officers of many of the institutions for the higher education of women in the United States was held this year at Smith College on April 18. The association, which numbers among its members eleven colleges for women and co-educational institutions, as well as associations and individuals, maintains a table at the Zoological Station at Naples, awarding places at it to from one to five persons each year. A place at the American Women's Table at this Station for 1903–4 was awarded to Dr. Grace Emily Cooley, associate professor of botany at Wellesley College, who will thus become scholar of the association. An additional award has, however, been made this year, that of the prize of 200*l.* offered two years ago for the best piece of scientific research work done by a woman. Twelve professors representing the biological, chemical, and physiological sciences act as board of examiners for the association. This year they considered eleven scientific investigations, and awarded the prize to Dr. Florence R. Sabin, assistant in anatomy at the Johns Hopkins University Medical School, for the results of an investigation on the origin of the lymphatic system. Honourable mention was given to the paper on the life-history of Pinus by Miss Margaret Ferguson. The prize of 200*l.* is again offered, to be awarded in 1905.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, April 24.—Mr. T. H. Blakesley, vice-president, in the chair.—Mr. W. B. **Croft** exhibited several novel and ingenious pieces of physical apparatus.—Dimensional analysis of physical quantities and the correlation of units, by Mr. A. F. **Ravenshear**. The object of this paper is to knit together various divergent views which are current on the subject of dimensions. It is shown that while (1) dimensional analysis and the correlation of units of different kinds can be pursued in one direction until, with completed correlation, we arrive at degrees of undifferentiated quantity, a different procedure may be followed which (2) gives rise to various systems of dimensions descriptive of the physical relationships of the quantities treated. The conditions giving rise to dimensional relations are first set out, and it is proposed to distinguish the purely quantita-

tive reading of a dimensional formula by enclosing the sign of equality in square brackets thus:—

$$[\text{force}][=][M][L][T^{-2}]$$

and the reading of it as a physical identity or equivalence thus:—

$$[\text{force}]\equiv[M][L][T^{-2}].$$

The dimensional relation $M=L^3T^{-2}$ derived from the law of gravitation is examined at length. This relation, combined with the demand for the complete correlation of all dynamical units, is shown to require the adoption of the convention

$$[L][=][T][=][M].$$

This result is interpreted by (1) above. Systems of dimensions are next discussed, with the aid of illustrative tables, and it is shown that by employing different physical laws as bases many different systems may be constructed.—Mr. R. J. **Sowter** read a note on dimensions of physical quantities. Mr. Ravenshear has shown that any physical quantity is expressible in terms of the dynamical quantities L, M and T, in different ways, but that all the various ways are connected with one another by an index law. One interpretation of this is that the dynamical factors are complete in themselves. They express change-ratios, and have no qualitative significance. μ, k, γ, &c. do not contain dynamical factors, but carry with them the physical qualities or characteristics of the quantities associated with them. Any physical quantity, on this hypothesis, is expressible as $Q=N(D^n)q$, where N is a mere number, (D^n) is a dynamical factor indicating a quantitative measurement process, and q is a quality factor of the nature of Q.

Geological Society, April 8.—Mr. J. J. H. Teall, F.R.S., vice-president, in the chair.—On the probable source of some of the pebbles of the Triassic Pebble-Beds of South Devon and of the midland counties, by Mr. O. A. **Shrubsole.** The author describes the Budleigh-Salterton Pebble-Beds. The supposition is natural that Devonian rocks were once represented either in the Calvados district or in some region in the same drainage-area as that which has supplied the Ordovician element. The Grès de May of Normandy appears capable of furnishing abundant material, not only for the Ordovician pebbles of the Budleigh-Salterton Pebble-Bed, but also for a great deal more. A list of species common to the Grès de May, of May itself, and the Budleigh-Salterton deposit is given. The author is struck with the resemblance of the Midland Bunter to that of Devon. Strong family likenesses subsist between certain specimens in the northern and southern Bunter and some of the undisturbed rocks of Normandy. A list of fossils from the Midland Bunter contains three southern forms. Fourteen out of twenty of the Drift and Bunter fossils are found at Budleigh-Salterton and in Normandy.—Note on the occurrence of Keisley-Limestone Pebbles in the Red Sandstone-Rocks of Peel (Isle of Man), by Mr. E. L. **Gill.** Pebbles of a coarsely-crystalline, greyish-white, mottled limestone, collected by Prof. W. Boyd Dawkins from the conglomerates at Whitestrand, contain the following fossils:—*Illaenus Bowmanni*, var. *brevicapitatus, Primitia Maccoyi, Orthis calligramma, O. testudinaria, O. biforata, Rafinesquina deltoidea, Plectambonites quinquecostata, Atrypa expansa, Hyatella Portlockiana, Dayia pentagonalis, Platyceras verisimile, Stenopora fibrosa*, and crinoid-stems. This assemblage of fossils corresponds strikingly with that of the Keisley Limestone, and it is therefore concluded that the pebbles have been derived from that rock.

DUBLIN.

Royal Irish Academy, April 27.—Prof. Atkinson, president, in the chair.—Observations on the temperature of the subterranean organs of plants, by Dr. Henry H. **Dixon.** Previous experimenters on the temperatures of plants have confined their investigations to the aërial organs. Dutrochet alone experimented with subterranean organs, but only after removal from the soil. He believed that these organs are at the same temperature as their surroundings. From the experiments described in this paper we may infer that (1) subterranean organs, *e.g.* bulbs, like aërial organs, may have during active growth a higher temperature than their surroundings. The amount of this temperature-elevation may be as much as 0.06° C. (2) After the period of active growth is passed, this temperature-elevation is no longer noticeable. (3) There is no true indication of a *spontaneous* periodic diurnal rise in the temperature of subterranean organs, such as has been recorded by other writers for aërial organs. A periodic diurnal rise may occur owing to the periodicity of the temperature of the surroundings, which in its turn may cause an increase in the metabolic activity of the plant, and so give rise to a periodic elevation of temperature. (4) In the less massive subterranean organs the temperature rise is not sufficient to make itself appreciable above the fluctuations of the surroundings and the errors of experiment. The paper also contains an account of the errors affecting the thermo-electric method of determining plant temperatures, and also of some suggestions with a view to minimising them.

PARIS.

Academy of Sciences, April 27.—M. Albert Gaudry in the chair.—The president announced the death of M. de Bussy, member of the section of geography and navigation.—On the radiation of polonium and on the secondary radiation which it produces, by M. Henri **Becquerel.** The radiation of polonium differs from that of radium by the absence of rays resembling the kathode rays. The chief portion of the polonium rays possesses identical properties with the α-rays of radium and the canal rays of Goldstein. Up to the present these have been the only polonium rays known, but the author has recently recognised the existence of other rays, distinguished by their powers of penetration. These penetrating rays produce effects which are in every way comparable with the penetrating rays of radium filtered through a considerable thickness of metal. Hence it would appear that of the three distinct kinds of radiation possessed by radium, polonium possesses only two, the part missing being that of a kathodic nature.—The eclipse of the moon of April 11 at the Observatory of Marseilles, by M. **Stephan.**—Observation of the partial eclipse of the moon of April 11 at the Observatory of Bordeaux, by M. G. **Rayet.** The atmospheric conditions were extremely favourable for observations; one peculiarity noticed in the eclipse was that whereas in ordinary eclipses the entire disc of the moon can be seen during the greater part of the eclipse, in this case the eclipsed part of the moon had completely disappeared. This was noticed both in the eye observations and the photographs.—The catalytic decomposition of alcohols by finely divided metals, allyl and benzyl alcohols, secondary and tertiary alcohols, by MM. Paul **Sabatier** and J. B. **Senderens.** It has been shown in previous papers that metallic copper, prepared by the reduction at a low temperature, reacts with the primary alcohols, giving the aldehyde and free hydrogen. This reaction has now been extended to allyl, benzyl, isopropyl and other secondary alcohols. Allyl alcohol gives a 50 per cent. yield of propyl aldehyde, and benzyl alcohol gives hydrogen and the aldehyde. Secondary alcohols give hydrogen and the corresponding ketone in good yields, provided that the temperature does not rise too high. Tertiary alcohols split up into water and ethylene hydrocarbons. Reduced nickel gives rise to similar reactions, but there is a tendency to further decomposition, and the yields are not so good.—M. Noether was elected a correspondant in the section of geometry in the place of the late M. Fuchs.—On the observation of the eclipse of the Moon of April 11, by M. P. **Puiseux.** The extreme blackness of the eclipsed portion of the moon, noticed by other observers, was also in evidence at Paris.—The eclipse of the moon of April 11–12, by M. A. **Kannapell.** The results of observations made at the Observatory of the Faculty of Sciences at Paris.—On the deadening of the tremors of the ground. The application of a bath with a thick layer of mercury, by M. Maurice **Hamy.** A study of the theory of the use of mercury baths in preventing oscillations. An apparatus designed to carry out the conditions indicated by these researches was installed in the neighbourhood of a 4 h.p. gas engine with very satisfactory results.—The calculation of the time and height of high tide by means of harmonic constants, by M. Rollet **de l'Isle.**—Observations of the sun made at the Observatory of Lyons with the 16 cm. Brunner equatorial during the first quarter of 1903, by M. J. **Guillaume.** The observations are given in three tables showing the number of spots, their distribution in latitude, and the distribution

of the faculæ in latitude.—On certain remarkable deformations, by M. Jules **Drach.**—On the carrying of the charge in experiments on electric convection, by M. N. **Vasilesco-Karpen.** A discussion of the question of a disc, carrying a variable electric charge, and rotating about its axis, as to how far the charge is carried round by its support? A calculation is given showing the number of turns made by the charge with respect to the disc in unit time. The slipping is proportional to the thickness of the disc and to the induced electromotive force.—On the cementation of iron, by M. Georges **Charpy.** Cementation is not limited by the solubility of carbon in iron. Under certain conditions, the iron may be completely converted into carbide of iron, or the carbon may be indefinitely converted into graphite by the action of a limited quantity of iron.—On the reduction of some compounds of the halogens with metals by hydrogen; the influence of pressure, by M. A. **Jouniaux.** The reduction of the chlorides, bromides, and iodides of silver and lead with hydrogen was studied at varying temperatures, and the experimental results compared with an expression deduced from thermodynamics.—On the electrolytic reduction of potassium chlorate, by M. D. **Tommasi.**—On a reaction giving rise to symmetrical diphenyl-pyrones, by M. R. **Fosse.** The method used consists in treating the phenol orthophosphates with potassium carbonate. Details are given for the reactions with the phosphates of phenyl, cresyl, and naphthyl.—The influence of the nature of the external medium on plant acidity, by MM. E. **Charabot** and A. **Hébert.** Those salts which favour the diminution of water in the plant are precisely those for which the ratio between the volatile acids esterified and the total volatile acidity is the highest.—The influence of the radium radiation on animals in the course of growth, by M. Georges **Bohn.**—On some proteolytic ferments associated with rennet in vegetables, by M. Maurice **Javillier.**—On the production of formic acid in alcoholic fermentation, by M. Pierre **Thomas.** Yeast cultivated in a mineral liquid containing sugar, a large surface of which is exposed to the air, may give rise to considerable quantities of formic acid if nitrogen in certain forms is present. Since ammonium salts and amides exist naturally in certain musts, it is not surprising to find formic acid in the resulting wines after fermentation.

DIARY OF SOCIETIES.

THURSDAY, MAY 7.

ROYAL SOCIETY, at 4.30.—On *Lagenostoma Lomaxi*, the Seed of Lyginodendron: Dr. F. W. Oliver and Dr. D. H. Scott, F.R.S.—On the Physiological Action of the Poison of the Hydrophidæ: Dr. L. Rogers.—Preliminary Note on the Discovery of the Pigmy Elephant in Cyprus: Miss D. M. A. Bate.

ROYAL INSTITUTION, at 5.—Hydrogen: Gaseous, Liquid and Solid: Prof. Dewar, F.R.S.

RÖNTGEN SOCIETY, at 8.30.—Exhibition Evening.

CHEMICAL SOCIETY, at 8.—(1) β-Bromonitrocamphor and β-Bromocamphoryloxime. Influence of Impurities in Conditioning Dynamic Isomerism; (2) Spontaneous Decomposition of Nitrocamphor: T. M. Lowry.—The Active Constituents of *Butea frondosa*: E. G. Hill.

LINNEAN SOCIETY, at 8.—The Ingolfiellidæ, fam. nov., a New Type of Amphipoda: Dr. H. J. Hansen.—The Evolution of the Marsupials of Australia: A. Bensley.—Copepoda Calanoida from the Faröe Channel, and Other Parts of the North Atlantic: Rev. Canon Norman, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Applications of Electricity in Engineering and Shipbuilding Works: A. D. Williamson.—Electric Driving in Machine Shops: A. B. Chatwood.

FRIDAY, MAY 8.

ROYAL INSTITUTION, at 9.—Rural England: H. Rider Haggard.

ROYAL ASTRONOMICAL SOCIETY, at 5.—A Possible Cause of the Moon's Obscuration on April 11: Rev. S. J. Johnson.—*Probable papers*:—Observations of Stars Occulted by the Moon during the Eclipse of 1903 April 11: Radcliffe Observatory, Oxford.—Observations of Double Stars made with the 28-inch Refractor: Royal Observatory, Greenwich.

MALACOLOGICAL SOCIETY, at 8.—On the Necessity of Examining and Comparing the Animals before Determining some Species of the Genus Oliva: F. G. Bridgman.—Notes on some British Eulimidæ: E. R. Sykes.—Note on the Occurrence of *Planorbis marginatus*, Drap., and *Limnaea peregra*, Müll., in the Pleistocene of Bognor, Sussex: Alexander Reynell.

PHYSICAL SOCIETY, at 5.—A Spectroscope of Direct Vision and Minimum Deviation: T. H. Blakesley.—Mathematics of Bee's Cells: Prof. Everett.—The Coloured Map Problem: W. H. Price.—Note on the Construction and Attachment of Galvanometer Mirrors: Dr. W. Watson.

MONDAY, MAY 11.

SOCIETY OF ARTS, at 8.—Mechanical Road Carriages: W. Worby Beaumont.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Cilicia, Tarsus, and the Great Taurus Pass: Prof. W. M. Ramsay.

TUESDAY, MAY 12.

ROYAL INSTITUTION, at 5.—The Astronomical Influence of the Tides: Prof. G. H. Darwin, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—A Contribution to the Study of Double Monstrosities in Fishes: James F. Gemmill.—The Metamorphoses of *Ægeon fasciatus* and *Ægeon trispinosus*: Robert Gurney.—Descriptions of new Species of South American Coleoptera of the Family Chrysomelidæ: Martin Jacoby.

WEDNESDAY, MAY 13.

SOCIETY OF ARTS, at 8.—The Preservation of the Species of Big Game in Africa: E. North Buxton.

GEOLOGICAL SOCIETY, at 8.—On some Disturbances in the Chalk near Royston: Horace B. Woodward, F.R.S.—On a Section at Cowley near Cheltenham, and its Bearing on the Interpretation of the Bajocian Denudation: L. Richardson.—Description of a Species of Heterastraca from the Lower Rhætic Deposits of Gloucestershire: R. F. Tomes.

THURSDAY, MAY 14.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—The Combination of Hydrogen and Chlorine under the Influence of Light: P. V. Bevan.—On the Photo-Electric Discharge between Metallic Surfaces: Dr. W. Mansergh Varley.—The Elasmometer, a new Interferential Form of Elasticity Apparatus: A. E. Tutton, F.R.S.—On the Radiation of Helium and Mercury in a Magnetic Field: Prof. A. Gray, F.R.S., and Dr. W. Stewart; with R. A. Houston and D. B. McQuiston.—Meteorological Observations by the Use of Kites off the West Coast of Scotland, 1902: Dr. W. N. Shaw, F.R.S., and W. H. Dines.

ROYAL INSTITUTION, at 5.—Proteid-Digestion in Plants: Prof. Sidney H. Vines, F.R.S

MATHEMATICAL SOCIETY, at 5.30.—Generational Relations Defining an Abstract Simple Group of Order 32736: W. H. Bussey.—Points in the Theory of Continuous Groups: Dr. H. F. Baker.

SOCIETY OF ARTS, at 4.30.—The Province of Assam: Sir James Charles Lyall, K.C.S.I.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Applications of Electricity in Engineering and Shipbuilding Works: A. D. Williamson.—Electric Driving in Machine Shops: A. B. Chatwood.

FRIDAY, MAY 15

ROYAL INSTITUTION, at 9.—The Origin of Seed-Bearing Plants: D. H Scott, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Etiology of Leprosy: Jonathan Hutchinson, F.R.S.

CONTENTS.

THURSDAY, MAY 14, 1903.

THE UNIVERSITY AND THE MODERN STATE.

III.

IN our last article on the above subject, we attempted to show the German view of the proper position of the University in a modern civilised community.

We now proceed to give, so far as a careful study of statistics can help us, a similar indication of the view held in the United States; our object being to show the real basis of the recent progress of those nations which are now outstripping us, not only in commercial enterprises, but in other ways where brain-power comes in. We are glad to know that the importance of universities as well as battleships for the maintenance of the life of a nation is at last being recognised.

Any consideration of what the nation has done for higher education in the United States must be prefaced by a reference to two laws passed in 1787 and 1862 respectively. The first Act, enacted for the government of the territory north of the Ohio, provided that not more than two complete townships[1] were to be given to each State perpetually for the purposes of a "university to be applied to the intended object by the legislature of the State." In 1862 an Act was passed giving to each State thirty thousand acres of land for each senator and representative to which the State was then entitled, for the purpose of founding "at least one college, where the leading object shall be, without excluding other scientific and practical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States shall respectively prescribe, in order to promote the liberal education of the industrial classes in the several pursuits and professions of life."[2]

A reference to Table i. below, showing the number of acres of land in each of the States, the income accruing from which is available for university education, demonstrates more conclusively than any words could do how very fully advantage has been taken throughout the United States of the legislative enactments of 1787 and 1862. The table is due to Dr. Frank W. Blackmar, and is contained in "The History of Federal and State Aid to Higher Education in the United States," published in Washington in 1890.

The grant of 1862 proved insufficient, and in 1890 an Act for the "more complete endowment of the institutions called into being or endowed by the Act of 1862" was passed.

But these land grants do not exhaust the means adopted by the State to encourage higher education in the United States. In the book to which reference has been made, Dr. Blackmar summarises the principal ways in which the several States have aided higher education. They are as follows:—

(1) By granting charters with privileges.
(2) By freeing officers and students of colleges and universities from military duties.
(3) By exempting the persons and properties of the officers and students from taxation.
(4) By granting land endowments.
(5) By granting permanent money endowments by statute law.
(6) By making special appropriations from funds raised by taxation.
(7) By granting the benefits of lotteries.
(8) By special gifts of buildings and sites.

TABLE I.—*Land Grants and Reservations for Universities.*

States and Territories.	Acres.	Dates of Grant.
Ohio	69,120	1792, 1803
Indiana	46,080	1816, 1804
Illinois	46,080	1804, 1818
Missouri	46,080	1818, 1820
Alabama	46,080	1818, 1819
Mississippi	46,080	1803, 1819
Louisiana	46,080	1806, 1811, 1827
Michigan	46,080	1836
Arkansas	46,080	1836
Florida	92,160	1845
Iowa	46,080	1845
Wisconsin	92,160	1846, 1854
California ...	46,080	1853
Minnesota	82,640	1861, 1857, 187
Oregon	46,080	1859, 1861
Kansas	46,080	1861
Nevada	46,080	1866
Nebraska	46,080	1864
Colorado	46,080	1875
Washington	46,080	1854, 1864
North Dakota } South Dakota } ...	46,080	1881
Montana	46,080	1881
Arizona Territory ...	46,080	1881
Idaho Territory ...	46,080	1881
Wyoming Territory ...	46,080	1881
New Mexico Territory	46,080	1854
Utah Territory ...	46,080	1855
Total...	1,395,920	...

The result is, as Prof. Edward Delavan Perry, of Columbia University, has said,[1] "At the present time, in each of the twenty-nine of the States of the Union, there is maintained a single 'State university' supported exclusively or prevailingly from public funds, and managed under the more or less direct control of the legislature and administrative officers of the State. These States are the following:—Alabama, California, Colorado, Georgia, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, North Carolina, North Dakota, Ohio, Oregon, South Carolina, South Dakota, Tennessee, Texas, Virginia, Washington, West Virginia, Wisconsin and Wyoming.

"The universal verdict of public opinion in the States where such institutions are maintained is that they, as State organisations supported directly by public taxation from which no taxable individual is exempt, should be open without distinction of sex, colour, or religion to all who can profit by the instruction therein given."

The figures necessary to express how much university education in the United States owes to the American Government are large, and the total amount of the aid is enormous. The following table, drawn up with the assistance of the Report of the U.S. Commissioner of Education for the year 1899–1900, will enable the reader to form some idea of the splendid resources placed at the command of American universities. The grand totals under each heading will be found in Tables v. and vi., so arranged as to show the proportion of each total available for the university education of women.

[1] In surveys of the public land of the United States, a division of territory six miles square, containing thirty-six sections.

[2] "Report of the Commissioner of Education for the Year 1896–7." Vol. ii. p. 1145. (Washington, 1898.)

[1] See Prof. Nicholas Murray Butler's monographs on "Education in the United States," vol. i.

C

TABLE II.—*Statistics showing Value, Endowments, Appropriations, Income and Benefactions of Universities and Colleges in the United States in* 1899–1900.

State or Territory.	Value of Libraries, Apparatus, Grounds and Buildings.	Value of Endowments—Productive Funds.	Tuition and other Fees.	Income from Productive Funds.	State, Municipal and U.S. Government Appropriations.	Income from other Sources.	Total Income.	Benefactions.
	£	£	£	£	£	£	£	£
Maine	351,200	377,900	17,600	17,500	14,000	3,000	52,100	13,900
New Hampshire	220,600	460,000	8,900	12,000	2,000	0	22,900	70,000
Vermont	198,700	165,000	3,600	9,100	8,100	1,500	22,300	28,700
Massachusetts	3,084,800	4,083,000	292,500	179,300	0	50,000	521,800	257,600
Rhode Island	301,700	259,400	19,400	15,700	0	300	35,400	30,400
Connecticut	1,577,800	1,414,300	106,900	69,700	0	5,700	182,300	156,400
New York	5,846,400	5,681,500	289,000	257,400	48,300	111,000	705,700	363,300
New Jersey	983,300	563,300	39,600	26,700	8,000	0	74,300	47,200
Pennsylvania	3,075,600	2,381,800	217,000	95,000	43,500	34,600	390,100	170,500
Delaware	34,000	16,600	300	1,000	8,000	600	9,900	—
Maryland	784,000	754,400	54,800	19,700	19,000	11,600	105,100	13,000
Columbia	974,900	279,400	34,300	14,700	20,600	14,700	14,300	14,600
Virginia	753,000	392,600	48,200	20,500	12,800	9,400	90,900	16,400
West Virginia	119,700	33,900	4,100	1,800	28,700	3,600	38,200	10,200
North Carolina	484,500	179,000	38,100	10,101	5,000	11,500	64,700	17,700
South Carolina	303,400	123,800	23,700	6,800	5,900	7,800	44,200	30,400
Georgia	491,600	184,400	37,900	11,400	5,400	8,600	63,300	20,700
Florida	104,800	85,100	4,500	5,400	4,500	0	14,400	3,500
Kentucky	437,100	332,400	33,700	17,000	13,400	9,800	73,900	27,500
Tennessee...	992,000	527,000	70,200	26,900	12,700	33,700	143,500	58,800
Alabama	325,800	70,000	20,300	2,400	2,500	6,000	31,200	2,100
Mississippi	233,000	180,300	23,800	8,300	12,900	8,000	53,000	200
Louisiana	436,300	387,900	18,800	25,000	8,600	1,700	54,100	3,000
Texas	444,600	143,900	46,000	7,600	15,600	21,000	90,200	20,100
Arkansas	133,300	33,000	10,000	2,400	13,300	1,600	27,300	3,900
Oklahoma...	14,600	—	200	0	3,800	0	4,000	—
Indian Territory	13,500	200	1,200	0	0	1,000	2,200	1,800
Ohio	2,114,900	1,901,500	91,200	84,700	64,400	26,300	266,600	133,600
Indiana	867,200	431,100	30,900	23,000	17,500	5,200	76,600	12,300
Illinois	2,256,000	2,310,500	199,400	96,800	61,500	31,100	388,800	386,900
Michigan	678,800	374,600	50,000	19,300	58,700	10,600	138,600	56,800
Wisconsin...	627,300	334,000	22,800	15,300	62,800	4,500	105,400	10,400
Minnesota...	627,100	332,700	35,200	15,400	35,100	8,900	94,600	15,200
Iowa	632,500	300,800	48,400	18,900	15,000	31,600	113,900	51,600
Missouri	1,359,800	737,300	77,200	33,800	14,900	19,600	145,500	67,400
North Dakota	47,700	8,000	1,000	600	9,100	0	10,700	4,800
South Dakota	92,400	20,000	4,600	800	6,600	1,100	13,100	19,200
Nebraska	451,300	67,300	13,700	3,800	46,400	4,400	68,300	9,400
Kansas	624,900	84,000	33,900	5,300	24,000	18,500	81,700	23,500
Montana	43,700	—	1,900	2,000	4,300	0	8,200	—
Wyoming	43,300	1,400	100	0	1,000	100	11,200	0
Colorado	343,300	124,000	8,000	7,400	14,400	2,200	32,000	46,600
New Mexico	16,500	—	100	0	2,200	0	2,300	2,700
Arizona	30,900	—	—	0	10,000	500	10,500	—
Utah	126,900	51,400	2,900	1,300	12,300	2,900	19,400	800
Nevada	50,400	—	—	—	11,400	0	11,400	—
Idaho	49 900	—	0	0	10,000	0	10,000	0
Washington	269,600	37,700	11,000	2,500	10,000	500	24,000	45,500
Oregon	124,900	89,000	5,200	4,400	6,000	900	16,500	5,600
California	1,376,000	4,250,200	41,100	78,500	55,300	3,500	178,400	11,300

But, as readers of NATURE are well aware, the universities and colleges of the United States have another source of income in addition to the generous provision made by the State. Every year wealthy American citizens place large sums of money at the disposal of the educational authorities for the purposes of higher education and the encouragement of scientific research. During the eleven years 1890-1901, the amount of these donations reached the grand total of nearly 23,000,000*l.*, as Table iii., compiled by Prof. Nicholas Murray Butler, shows:—

TABLE III.—*Total amount of Benefactions*[1] *to Higher Education in the United States.*

Reported in	£	Reported in	£
1890–91 ...	... 1,515,018	1896–97 ...	... 1,678,187
1891–92 ...	... 1,336,917	1897–98 ...	... 1,640,856
1892–93 ...	... 1,343,027	1898–99 ...	... 4,385,087
1893–94 ...	... 1,890,101	1899–1900	... 2,399,092
1894–95 ...	... 1,199,645	1900–01	... 3,608,082
1895–96 ...	... 1,810,021		

[1] Compiled by Prof. Nicholas Murray Butler, Columbia University, and published in "Special Reports on Educational Subjects," vol. xi. part ii.

From 1871–1890, the total amount of benefactions for education of the kind with which this article is concerned, was, the annual reports of the U.S. Bureau of Education show, 16,285,000*l.*, so that for the years 1871–1901, the grand total of forty millions sterling was raised by private effort for American university education.

The question naturally presents itself: What has been done by private effort in this country to assist university education during the same period? Compared with American munificence, the amounts given and bequeathed here are very small. Take in the first place the university colleges, which are largely to be regarded as a growth of the years under consideration. The financial statements contained in the "Reports from University Colleges, 1901," published by the Board of Education, reveal the fact that, including the 400,000*l.* raised for the University of Birmingham, the benefactions to the fifteen university colleges in Great Britain amounted during 1870–1900 to a little more than three millions. In the absence of systematic reports during the same period of the financial resources of the older universities of the United Kingdom, it is difficult to estimate the amount of benefactions received by them during the same thirty years. The parliamentary returns which have been published since 1898, showing the revenue of Scottish universities, suggest that their benefactions in the same time, excluding Mr. Carnegie's splendid gift, may be put at something under half a million, so that for the whole of the United Kingdom the total amount of endowment from private sources raised in these years may, without any risk of under-estimation, be said to be considerably less than five millions.

To give some idea of the result of the broad-minded policy of the legislatures of the several States and of the treatment which higher education has received at the hands of American statesmen and men of wealth, the following short summaries have been drawn up, with the assistance of the Report of the Commissioner of Education of the United States Bureau at Washington, published in 1901, for the year 1899-1900. The first (Table iv.) shows the number of colleges having endowments of certain specified amounts. The second summary (Table v.) shows the total property of all American university colleges, tabulated under the headings of fellowships and scholarships; values of libraries, apparatus, grounds and buildings; and of their productive funds. The next (Table vi.) shows the amounts of income of these colleges, and the last (Table vii.) gives the total number of professors, instructors and students in colleges of university standing.

It is interesting in this connection to compare the number of students taking university courses in this country with those in Germany and the United States. With this object in view, Table viii. has been pre-

TABLE IV.—*Classification of Colleges and Universities for Men and for both Sexes, according to Amount of Endowment Fund.*

£		£	
20,000	to	40,000	56
40,000	,,	60,000	38
60,000	,,	80,000	13
80,000	,,	100,000	14
100,000	,,	120,000	7
120,000	,,	140,000	4
140,000	,,	160,000	5
160,000	,,	180,000	2
180,000	,,	200,000	1
200,000	,,	250,000	8
250,000	,,	300,000	5
300,000	,,	400,000	3
400,000	,,	600,000	4
600,000	,,	800,000	4
800,000	,,	1,000,000	1
1,000,000	,,	1,500,000	2
1,500,000	,,	2,000,000	—
		Over 2,000,000	3

TABLE VII.—*Professors, Instructors and Students in Universities and Colleges of United States.*

Institutions.	Professors and Instructors.[1]	
	Men.	Women.
For men and for both sexes (480 institutions)	12,664	1,816
For women (141 institutions)	697	1,744
	Students.	
	Men.	Women.
Total number of students in universities and colleges ...	61,800	35,300

TABLE V.—*Property of Universities and Colleges in the United States* (1899–1900).

Description of institution.	Number of fellowships.	Number of scholarships.	Value of libraries.	Value of scientific apparatus.	Value of grounds and buildings.	Productive funds.
			£	£	£	£
For men and for both sexes	476	7,619	2,138,000	3,027,000	27,267,000	29,478,000
For women	18	447	132,000	157,000	3,129,000	1,088,000

TABLE VI.—*Income of Universities and Colleges in the United States* (1899–1900).

Description of institution.	Fees.	From productive funds.	State or municipal appropriations.	From United States Government.	From other sources.	Total income.	Benefactions.
	£	£	£	£	£	£	£
For men and for both sexes	1,675,000	1,222,000	691,900	197,000	393,000	4,179,000	2,168,000
For women	468,000	57,000	7,000	—	136,000	670,000	118,000

[1] Excluding duplicates.

pared, but it should be pointed out that the number of students in our university colleges includes all above the age of sixteen, which is probably much lower than the age of the students included in the totals for other countries. It is well to remember, too, that the number of American university students is probably too high for a fair comparison with those of Germany. Many university students in the United States are really students in the higher branches of technology, and would in Germany study in technical high schools, the students of which are not included in Germany's total in the table. To make the comparisons as simple as possible the number of university students per ten thousand of population has been calculated.

TABLE VIII.—*Number of University Students per* 10,000 *of Population* (1900).

Country.	Population.	Number of Students.			Number of Students per 10,000 of Population.
			Day.	Evening	
United Kingdom	41,164,000	Universities	12,000		4·98[1]
		University Colleges	8,500	5,000	
German Empire	56,367,000	44,400			7·87
United States	76,086,000	97,100			12·76

[1] Excluding Evening Students of University Colleges.

The statistics provided above make it possible to form a good estimate of the comparative amounts of importance attached to higher education in this country and in the United States. Table vi. shows that, neglecting the income accruing from the State land grants, the legislatures of individual States and the U.S. Government together supplied about 900,000*l.* for university education during 1899–1900, while the article in NATURE for March 12, 1903, shows that the total State aid to universities and colleges in the United Kingdom at present amounts only to 155,600*l.* Table vi. also brings out another important principle; it reveals the fact that during 1899–1900 private effort provided more than two and a quarter millions sterling for the colleges of the United States, and thus leads to the conclusion, which is strengthened by Table iii., that interest on the part of the State in higher education leads to a corresponding enthusiasm among men of wealth.

A comparative study of this kind is of vital national interest; our very existence as a nation depends directly upon success in that industrial warfare between the great countries of the world from which there can be no peace. The last article in this series has shown the great importance attached by German statesmen to the higher education of the directors of German industries, and how greatly superior is the provision made for this purpose in Germany to that in this country. A similar conclusion is reached by studying the subject from the American point of view; we are equally behind the United States. Unless our Government, on one hand, and our men of wealth on the other, take immediate steps, and make serious efforts to remedy these deficiencies in our higher education, British manufacturers cannot hope to hold their own successfully with either German or American competitors. The amount by which we fall short of the United States, the deficiency which must be made good simply to bring us level with America in the race for industrial supremacy, will be seen from the following deductions from the above statistics:—

(1) The amount raised during 1871–1901 by private munificence for higher education was, in the United States, more than eight times that similarly provided in the United Kingdom.

(2) In addition to the large income from State land grants, the amount provided by the State for higher education is, in the United States, six times as much as the Government grant for the same purpose in the United Kingdom, where there is nothing corresponding to the land grants.

(3) In the United States there are 170 colleges with an endowment of more than 20,000*l.*; forty-nine of these have endowments of more than 100,000*l.*, and three of more than two millions sterling. In the United Kingdom there are thirteen universities and twenty other university colleges. Four of the universities do little more than examine.

(4) In the United States nearly thirteen of every ten thousand inhabitants are studying during the day at colleges of university status; the number in the United Kingdom is less than five.

(5) The value of the endowments of institutions of higher education in the single State of New York exceeds the total amount of benefactions for similar purposes raised during thirty years in the whole of the United Kingdom. The same is nearly true in the States of Massachusetts and of California.

(6) The number of *professors and instructors* at the universities and colleges included in the list of the U.S. Commissioner of Education is 17,000. The number of *day students* in our universities and university colleges is only about 20,500, so that there are almost as many university *teachers* in the United States as there are university *students* in the United Kingdom!

In considering what should be the strength of the British Navy, the first line of national defence as it is called, it is commonly said that we must aim at making it equal to the combined fleets of any two first-class powers. When rightly regarded, the development of the brain-power of the nation is, in view of the fact that the ability to keep up the Navy depends upon commercial success, of even greater importance. Our provision of higher education, far from being equal to that of two of our chief competitors together, is by no means equal to either of them singly.

A careful study of the tables here brought together will do more than anything else to explain the success which has attended American manufactures and commerce in recent years. America has learnt that to energy and enterprise must be added trained intellect and a familiarity with recent advances in science. Other things being equal, that nation will be most successful in the competition for the markets of the world which makes the most generous provision for the higher education of its people.

We are glad that even if the Government is supine, our captains of industry are waking up; and we may conclude by a reference to the *Times* report of the speech delivered by Sir John Brunner at the remarkable gathering in connection with the Liverpool School of Tropical Medicine on Monday last, in which he repeated what he had already said to Sir Norman Lockyer in private.

"If we as a nation were now to borrow ten millions of money in order to help science by putting up buildings and endowing professors we should get the money back in the course of a generation a hundredfold. There was no better investment for a business man than the encouragement of science, and he said this knowing that every penny he possessed had come from the application of science to commerce."

GEOLOGY FOR AGRICULTURAL STUDENTS.

Agricultural Geology. By J. E. Marr. Pp. xi+318. (London: Methuen and Co., 1903.) Price 6*s*.

IN the teaching of any technical subject, like engineering or agriculture, which touches and depends upon several of the pure sciences, there has always been dispute about the amount and nature of the pure science to be exacted from the technical student, the present controversy over mathematics for engineers being a notable example. In the past, as a rule, the pure science man has ruled the roast, secure in a plausible logical position which regards the technical as "applications" of the principles laid down in the pure science, as "riders" in fact; now, however, he has, thanks to the spread of truer conceptions of education, to justify his teaching and discard those intellectual gymnastics which leave the student "as he was," and confine himself to a development of the subject to the given end.

In the book before us, Mr. Marr has put together that portion of geology with which a serious agricultural student ought to be equipped as a basis for his study of soils; more particularly the book is intended for candidates preparing for the examination for the National Diploma in Agriculture.

The earlier part of the book seems to us to be admirably suited to the agricultural student; he will get from it just the introductory knowledge of minerals and rocks, rock structures, and the work of geological agencies that he requires for an intelligent appreciation of the structure of the country. There is nothing superfluous, and, on the other hand, the proper point of view is obtained, the subject is developed as a whole, and not allowed to become a series of scraps of useful knowledge.

Two excellent chapters follow on the construction and interpretation of geological maps and sections, but we should have liked to see the later chapter on "water supply" brought into connection with this section, and treated in much more detail. To the agriculturist, structural geology is in the main important only as bearing upon water supply; it is fundamental that he should be able to read a geological map so as to gauge the probabilities of obtaining either surface or deep-seated water at a practicable depth, or to trace the origin of landsprings and decide upon a plan for tapping them or otherwise drying the land. We trust Mr. Marr will see his way in another edition to work out for the student some examples of the varying conditions of water supply, not by generalised diagrams, but from the actual survey maps.

The weakest part of the book is the last, the chapters dealing with stratigraphical geology; the economic products are but lightly touched upon, and the agricultural character of each formation is dismissed in a very sketchy and generalised fashion. If we compare the two pages or so devoted to the structure of Graptolites—the chitinous rod, the periderm, the hydrothecæ, &c.—with the amusing reference to the clay-with-flints, "Little will grow on it, though in places it has been made to yield good root crops," we see the difference between Mr. Marr the geologist, writing of what he likes and understands, and Mr. Marr "getting up" things for the agriculturist. Lastly, we should have liked a little more about the "drift" and the superficial deposits generally, for the farmer is more concerned with them than with the solid geology. In this connection we should like to know Mr. Marr's evidence for the following statement (p. 128):—

"One very important character of glacial drift from the point of view of soil formation is due to the fact that the disintegrating action of ice is purely mechanical, and, consequently, the soluble constituents of the rocks from which the drift has been derived have not been removed. These soluble constituents may be taken up by the plants but slowly, and accordingly the drift soils may not yield such abundant crops as other soils at the outset, but, on the other hand, they may continue to furnish supplies of these soluble materials long after those of other soils have been exhausted."

We are not sure we understand the meaning of this paragraph, but at any rate we demur to the apparent implication that soils become exhausted by cultivation as practised in this country.

APPLIED MECHANICS.

Elementary Applied Mechanics. By Profs. T. Alexander, C.E., and A. W. Thomson, D.Sc. Pp. xx+575; 281 illustrations. (London: Macmillan and Co., Ltd., 1903.) Price 42*s*.

THE title of this book is misleading. It is really a large and fairly advanced work dealing with certain engineering problems usually, now, classed under the headings "Strength of Materials" or "Theory of Structures." Simple problems in connection with stress and strain are taken up in chapter i., useful numerical examples being given by way of illustration and enforcement. Such examples, in fact, form a valuable feature of the work throughout. The authors—professors at Trinity College, Dublin, and Poona, India, respectively—dedicate the book to the memory of their late teacher, Prof. Rankine. Their study of that great authority has not, however, produced that terseness and lucidity of expression now so much prized. Thus the lengthening of a strut is called "augmentation," and shortening, we are led to infer, is "negative augmentation." Again, we read,

"The *Proof Load* is the stress of greatest intensity which will just produce a strain having the same ratio to itself which the strains bear constantly to the stresses producing them for all stresses of less intensity. If a stress be applied of very much greater intensity, the piece will break at once, &c."

One notices circumlocutions of this kind in various places.

Internal stresses and strains, simple and compound, are next taken up, and a picture of a model for illustrating Rankine's "ellipse of stress" is given and explained.

The stability of earthwork is dealt with in chapter iv.—as usual in such investigations, all depends on a knowledge of the "angle of repose," a very variable

quantity, and one not easily found practically. Chapter v. is devoted to the design of masonry retaining walls; the table of thicknesses for walls and the graphical solutions at the end of the chapter are particularly valuable. Chapter vi. commences an important section dealing with transverse stress, and relating mainly to the strength and stiffness of beams. After discussing the position of the neutral axis and the stress at a point in the section, the authors, oddly enough, give a chapter on the parabola, such as one might expect in a work on descriptive geometry. A clearly written chapter on graphical statics might have been introduced here with advantage. Diagrams of bending moment and shearing force are next discussed, and we come to the subject of continuous beams—one of increasing importance. Diagrams of shear and bending for girders with moving loads are then taken up at length, and a model is illustrated showing how the variations in these quantities, as a model loco. passes over a model bridge, may be exhibited to a class.

Combined live and dead loads are next considered, and approximations by the introduction of a so-called "equivalent live load" are dealt with at some length in chapter xiii., after which the *resistance* of a section to bending and shear is discussed, some neat graphical methods of finding the moment of inertia of, and the amount and distribution of shearing force at, a section being explained.

The very interesting use of the polariscope in investigating internal stress and strain, due to the late Prof. Peter Alexander, is fully described. Questions relating to curvature are next dealt with, the integral calculus being freely used. Amongst all the mass of weighty matter one does not find, so frequently as might be, useful practical rules and results set out clearly in heavy type. For instance, the point of, and amount of, the maximum deflection of a beam fixed at one end and supported at the other, with different distributions of loading, is often wanted in practice—we do not notice it prominently given here.

Struts, various kinds of trusses, linear arch ribs, &c., are taken up, analytical methods having the prominence rather than graphic methods, though the latter are employed to a very limited extent.

Tables relating to the "two-nosed catenary," the design of segmental arches, and other like matters bring this not at all elementary, yet valuable, work to a close except for an appendix, in which graphic methods are applied to a roof truss—evidently as an afterthought. R. G. B.

OUR BOOK SHELF.

The Principles of Animal Nutrition, with Special Reference to the Nutrition of Farm Animals. By Henry Prentiss Armsby, Ph.D., Director of the Pennsylvania State College Agricultural Experiment Station. Pp. vii+614. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 17*s*.

THE growth of institutions similar to that with which the classical labours of Lawes and Gilbert in this country are associated has been nowhere more marked than in the United States of America. The natural advantages of unlimited territory and virgin soil have no doubt much to do with the position of agricultural industry in that country, but added to this has been the recognition by the American people that farming, to be a success, must be conducted on scientific principles. Our Canadian cousins cannot be said to be behind their neighbours in this respect. The numerous and valuable memoirs which are being constantly issued from these agricultural experiment stations speak much for the industry and acumen of those engaged in conducting and superintending research there.

Dr. Armsby's book is a very successful attempt to present the present results of such work, so far as it relates to nutrition, in a systematic manner. It is, however, not a mere handbook for the stock raiser, but will amply repay careful perusal by students of physiology. It is a veritable mine of valuable statistics, and nowhere do we remember to have seen more clearly stated the great problems of metabolism and the methods by which they have been, and may be, solved. The law of the conservation of energy is as true for the chemistry of the living organism as it is for that of the laboratory, and it has been Rubner's epoch-making work to demonstrate that this can be experimentally verified. Much in the present book is naturally taken from Rubner; other names prominently quoted are those of Zuntz and Atwater. References are given to all important papers cited, and this materially enhances the value of Dr. Armsby's book. Where so much is excellent, it seems rather like carping criticism to point to minor deficiencies. We cannot, however, help noticing that the author's views on the digestion of proteids taken from a book published nearly ten years ago are somewhat antiquated; Kühne's theory on the hemi- and anti-products of gastric proteolysis has now been abandoned. The statement, also, that the fat of the food is absorbed largely in the form of an emulsion requires revision. In connection with the question of uric acid formation, Dr. Armsby does not appear to have grasped the now well-established fact that the formation of this substance in the bird is mainly synthetical, while in the mammal it is mainly, if not entirely, oxidative; he need not, therefore, hesitate to accept the view of its origin from nuclein and purin in these animals.

We, however, congratulate the author most sincerely on the book as a whole. So many books that one comes across nowadays are repetitions or imitations of others that it is refreshing to come across one which forms a material addition to knowledge.

Chemical Technology. Vol. iv. Electric Lighting. By A. G. Cooke, M.A., A.M.I.E.E., and Photometry, by W. J. Dibdin, F.I.C., F.C.S. Pp. xviii+378. (London: J. and A. Churchill, 1903.) Price 20*s*.

ONE must not expect too much of a book which aims at treating, in less than 300 pages, the whole subject of electric lighting, from the generation of electric energy in the central station to the manufacture of the lamp for its consumption in the user's house. As a work of reference for technical men engaged in other branches of work, but coming occasionally into contact with electrical engineering, this book should prove useful, just as an article in an encyclopædia is useful. And just in the same way as an encyclopædia article is defective, it seems to us that the book before us fails; by endeavouring to give too much information it only succeeds in giving too little. These objections apply rather to the scheme of the work than to the way in which Mr. Cooke has carried it out, which is as satisfactory as possible in the circumstances. In some instances the book is very much up-to-date; thus, it is probably one of the first text-books containing a good description of the Nernst lamp, though it is to be

regretted that the type of lamp illustrated is not the one sold in this country. In other places there is an apparent want of knowledge of recent progress, as, for example, where the oscillograph is spoken of as an instrument of little value, the point-to-point method being described as more practical. These, however, are minor blemishes, such as must be expected in a comprehensive work in which different branches are not written by separate experts. On the whole the book is to be commended; the illustrations and curves are good and well selected.

The last hundred pages of the volume deal with the subject of photometry; all the more important types of photometer are described and illustrated, and the various standards of light are carefully considered. It is perhaps to be regretted that this part of the book should refer more especially to gas photometry, since the remainder is devoted to electric lighting; but then it is altogether somewhat surprising to find a book on electric lighting forming one volume of a series on chemical technology. M. S.

Die empiristische Geschichtsauffassung David Humes, mit Berücksichtigung moderner methodologischer und erkenntnistheoretischer Probleme. Eine philosophische Studie von Dr. Julius Goldstein. Pp. 57. (Leipzig: Verlag der Durr'schen Buchhandlung, 1903.) Price 1.60 marks.

THIS essay may be described as a chapter in the history of applied philosophy. In Hume the author sees an unique example of the philosopher applying his own principles to history. In this case the experiment was of little advantage to history. Hume's well-known views on causation, the self, and uniformity leave history destitute of any "inner essence," individuals or real meaning.

The author relieves these somewhat trite observations by concrete examples from Hume's "History of England." Apart from these, the essay has been, in the main, anticipated by Leslie Stephen's "English Thought in the XVIIIth Century." Perhaps we should not forget that this is a German book. Its value lies solely in focusing attention on Hume as an example of the way history should not be written. The real value of Hume's work is hardly touched; he is ranked above Voltaire, but shares with the Enlightenment the glory of having failed well. As to the question of method, there is here only a negative contribution. Not only has the failure of Hume and the Enlightenment left chaos, but the author leaves it quite an open question how history is to become a science. That may be wisdom, but then the title seems disproportionate. In the references to Green and Grose for P.H. (*passim*) read T.H. On p. 51 (note) the reference is i. S. 378, &c. (not ii.). Siegwart is, of course, Sigwart (p. 11). "Aepinus" (p. 39) and the Englishman "Marivaud" (p. 56) are scarcely recognisable, but probably symbolise "Aquinas" and "Merivale."

G. S. B.

Arithmetic. Part i. By H. G. Willis, M.A. Pp. viii+256+l. (London: Rivingtons, 1903.) Price 1s. 4*d*.

THIS collection of examples on the simpler parts of arithmetic is arranged in a convenient and workable manner. The exercises are divided into thirty-nine groups, each containing work enough for two or three lessons; there are, moreover, duplicate sets of exercises which can, if necessary, be used in alternate terms. Oral questions are set at the beginning of each exercise. A few examination papers, tables of reference, and answers are given at the end of the book. The volume is likely to prove useful for junior forms.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Action of Live Things in Mechanics.

DR. HOBSON (p. 611) appears to hold the view that if dynamical laws are exact and irrefutable, the universe must be a completely determined mechanical system, with only one, and that a necessary, solution.

I hold, on the other hand, that though dynamical laws when properly stated are perfectly true, they do not cover the whole region of existence, and that, accordingly, it is possible for live things to affect the motions of matter in an unpredictable and capricious manner, though always in accordance with the laws of motion.

Dr. Hobson says, or implies, that they cannot so interfere without destroying the complete validity or supremacy of mechanical laws, and that they may as well upset the law of the conservation of energy as any other.

I reply that it is a question of fact whether they do or not. Experience seems to me to prove:—

(*a*) That live animals do introduce fresh considerations and do disturb things—do not take the path of least resistance, for instance; they are actuated by all sorts of non-mechanical motives, climbing the Matterhorn when there is no necessity, and building structures which would not otherwise be built.

(*b*) That in so doing they never run counter either to the conservation of energy or to any other fundamental mechanical law; they utilise the mechanical energies which lie ready to their hands, directing them, but leaving their amount unaltered.

[I emphasise the energy aspect because I so often find philosophers assume that any interference of life with inanimate matter must contradict the conservation of energy, or else must involve the doctrine that life itself is a form of energy.]

I ask Dr. Hobson to admit that a unique solution of all future material motions is only possible in a problem from which all other aspects of the universe have been abstracted, so that we limit ourselves by hypothesis to a purely dynamical system.

There are many things in the universe beside mechanics, some of which, by odd chance, are enumerated in a footnote accidentally occurring below Dr. Hobson's letter. For simplicity it is customary to eliminate all these from dynamical problems. But the questions at issue are:—

(1) Whether any of these things can interact with or influence a dynamical system at all.

(2) Whether they can so interact without upsetting or contradicting any fundamental dynamical laws.

I wish to answer both these questions in the affirmative. But it must be understood that by "dynamical laws" I mean the fundamental ones—let us say those of Newton. I do not mean modern generalisations or comprehensive summaries, like the principle of Least Action, the applicability of which can only be postulated on certain simplifying assumptions—assumptions or abstractions which, in the present instance, merely beg the question in dispute.

If Dr. Hobson does not agree with this, I trust he will give us the benefit of his further criticism.

May 2. OLIVER LODGE.

The Glorification of Energy.

PROF. TAIT, whenever he wrote of the principle of the conservation of energy, almost invariably spoke of it as the "grand" principle of conservation of energy; and, following his lead, all but the most sober mathematicians use the laudatory adjective when they write about this particular physical principle.

It may not be altogether superfluous to point out that there are other principles equally entitled to the epithet "grand." For example, there is the "grand" principle of the conservation of matter; there is the "grand" principle of the conservation of force, the sum total (algebraic) of which in the universe is zero, according to Newton's

Axiom ii.; there is the "grand" principle of the conservation of momentum, the algebraic sum total of it along any direction in the universe being constant (and possibly zero) by Newton's Axiom iii.; as well as the "grand" principle of the conservation of energy.

Now I hold that it is invidious to apply laudatory epithets of various degrees to these principles; but it may not be wrong to point out that in many respects the momentum principle has a marked advantage over the energy principle, the former being very often very easily, and without any danger of error, applicable, while the latter (owing to the elusiveness of energy) is full of danger to the unwary.

Postulating now the existence of spirit, we find a difficulty in defining this entity; but no greater mystery attaches to it than that involved in matter. The spiritualists imagine that they gain something by calling matter hard and contemptuous names—"mere" matter, "gross" matter, "mere gross" matter, &c. The names are harmless, and do not assist ideas in any way.

Postulating, then, the existence of a spiritual domain, the crucial question arises: does Newton's Axiom iii. hold for the interaction of the domains of matter and spirit? If it does, there is no dynamical principle interfered with; *in the dual domain* there are conservations of force, of momentum and of energy; but in the physical universe, *taken separately*, neither force nor momentum would be conserved, although energy might. On the other hand, if Newton's Axiom iii. does not hold for the interaction of the two domains, no principle of conservation could be enunciated for either domain, or for the system of the two together.

Sir Oliver Lodge is anxious to make out the existence of a spiritual domain, and to allow it a certain influence on the physical, which influence, however, "perturbs physical and mechanical laws no whit." How does he effect this? By assuming (to put the thing into mathematical language) that the forces exerted on material things by the spiritual are forces which do no work—such as are reactions of smooth fixed surfaces, tensions of inextensible cords, &c. These are sometimes called "deviating" forces. Sir Oliver calls them "guiding and controlling" forces. But it matters not what they are called, they fail in their object. They allow, indeed, the physical universe to keep its sum total of energy intact, but they infallibly alter its total momentum and total force in every direction.

When Sir Oliver says "guidance and control are not forms of energy, and their superposition upon the scheme of physics perturbs physical and mechanical laws no whit," he says what is perfectly true of any conceivable forces—whether merely "guiding" or not. However force may be produced on a material particle, the effect on the particle will certainly be in accordance with Newton's Axiom ii.; so that, in the sense in which Sir Oliver's statement is true, there is no necessity to postulate that spiritual forces are forces which act on matter but do no work.

It is a physical and mechanical law that when any system of material particles is subject to no forces but its own internal forces, the centre of mass of the system is either at rest or in uniform motion in a right line, and also that its sum total of energy, kinetic and dynamic, is constant. But if Sir Oliver Lodge implies that *both* of these results can remain unaltered if that material system is acted on by spiritual forces, he is certainly wrong. His deviating, or "guiding," spiritual forces can leave the total energy (kinetic and dynamic) of that material system unaltered, but they must inevitably interfere with the rest, or constant motion, of the centre of mass. Many of his readers may take this meaning out of his words; but I am sure that he cannot intend to be thus understood.

It seems to me that Dr. Hobson in his letter on the subject has done well to direct attention to the real status of the "grand" principle of the conservation of energy.

GEORGE M. MINCHIN.

Coopers Hill, Englefield Green, Surrey.

Psychophysical Interaction.

As a psychologist I have read with deep interest Sir Oliver Lodge's paper in your issue of April 23, and I write to ask him to make clear some points which his paper leaves obscure to my mind. Those of us who are not mathematicians feel themselves to be very much at the mercy of those who are, and we can only beg the physicists to remember our infirmity and to put their statements before us in the clearest, simplest, and most carefully chosen language. Sir Oliver Lodge, as Clerk Maxwell did before him, throws out to psychologists the suggestion that mind may act upon body by exerting guidance without doing work. Such guidance, we are told, may be effected by the application of force to moving masses in the nervous system in directions perpendicular to the direction of the movements of those masses. "Guidance is a passive exertion of force without doing work; as a quiescent rail can guide a train to its destination, provided an active engine propels it." This is the sentence that I find so indigestible. And my confusion is but increased by Sir Oliver Lodge's further illustrations. He distinguishes two kinds of force. "Force in motion is a 'power,' it does work and transfers energy from one body to another. But a force at rest—a mere statical stress, like that exerted by a pillar or a watershed—does no work, and alters no energy; yet the one sustains a roof which would otherwise fall, thereby screening a portion of ground from vegetation; while the other deflects a rain-drop into the Danube or the Rhine." And, again, we read that life can exert "the same kind of force which can constrain a stone to revolve in a circle instead of in a straight line; a force like that of a groove or slot or channel or 'guide.'" My first question is, Is it fair to say that the pillar supporting the roof exerts a force in the same sense as the rail which guides the train, the roof which guides the rain-drop, or the hand which holds the string? In the first case there is no motion, and therefore no change of direction of motion, no alteration of energy; in the other cases there is motion and alteration of direction of motion. Secondly, is it fair to call the rail quiescent? In guiding the train round a curve does not the rail, and the mass to which it is made fast, suffer an acceleration or a change of motion in the direction opposite to that of the train? When I swing round a heavy ball on a string, and feel it pulling my hand centrifugally, and when by muscular effort I resist the pull, is that "a passive exertion of force without doing work"? Or, if the string is fastened to the end of an upright pole, is there not movement of the mass to which the pole is fixed in the direction opposite to the deflection of the movement of the ball? Every kind of mechanical guidance that I can picture to myself seems to imply action and reaction, change of direction of one momentum seems to imply always an opposite change of direction of an equivalent momentum. This is, I suppose, the mechanical law of conservation of momentum, of which Prof. James Ward tells us that it is incompatible with the conception of guidance without work. I ask Sir Oliver Lodge whether we are to understand that he is prepared to throw this one mechanical law to the wolves in order to preserve the rest of the creed of the physicists unharmed by Prof. Ward's attack? Or are we to understand that he repudiates the law of conservation of momentum *in toto*? In that case, I ask him to describe for us clearly a single case of mechanical guidance in which momentum is not conserved, or, since my use of the phrase may be technically incorrect, I ask him to describe a case of change of direction of motion of any mass produced without expenditure of energy or opposite change of direction of motion of other mass or masses.

I submit that Sir Oliver Lodge abstracts from the idea of motion the attribute of direction in space, and that such abstraction is illegitimate, save for certain purely theoretical purposes. All motion has direction in space, which would seem to be an essential element in all considerations of energy values. Sir Oliver tells us that life and mind cannot generate energy, though they can guide moving masses by exerting forces perpendicular to the direction of motion. But consider, then, the following case. Imagine a universe consisting of two inert masses flying through empty space in the same direction and at the same rate, and a soul contemplating them. That universe would be devoid of energy. Then suppose the soul to exert a force upon one of the two masses, perpendicularly to its direction of motion, so as to swing it round through a semicircle until it rushes to meet the other mass. The soul, by "guidance," has then created energy, and I take it that the same considerations would hold true in our more complex universe.

But this difficulty in conceiving that mind or soul can play a part in the world of matter by acting upon masses in the brain exists only for those who persist in holding the untenable hypothesis that all energy is kinetic energy, is the motion of matter. This has proved, of course, an excellent working hypothesis, but that it is true of all forms of energy is nothing more than a pious hope. Yet it is the definition of energy in these terms (tacitly or explicitly) that perpetuates the ancient difficulty of conceiving the relations of mind and body, and it is the persistent adherence to this conception that, on the one hand, has landed so many minds in the absurdities of psychophysical parallelism, and, on the other hand, drives so many others to refuse a general acceptance of the law of conservation of energy, and to believe in an activity of the soul unconditioned by the past, a belief which destroys the rational basis of morals and renders a science of history and of society impossible.

To me it seems that this fundamental problem can only be properly stated when we cease to regard matter as the ultimate physical reality, when with Prof. W. Ostwald we say, "Matter is no longer present for us as a primary conception; it arises as a secondary phenomenon through the constant coexistence of certain forms of energy. We shall therefore have to frame the question in a new form—How are psychical phenomena related to the energy-concept?" and "that in the case of psychical processes we have to do with the rise and the transformation of a special kind of energy, which we, in order to be able to speak of it, will name provisionally psychical energy (geistige Energie)."[1]

Haslemere, April 26. W. McDOUGALL.

I HAVE pleasure in answering Mr. McDougall's questions so far as they are addressed to me.

In the first place I have not presumed to say how psychic control actually is exercised; but, in contradistinction to those who hold that control or guidance is impossible without the generation or introduction of fresh energy, I have pointed out that very simple and familiar mechanical arrangements do constantly exert guidance without doing any work; for instance, a line of rails.

Mr. McDougall thereupon asks me whether the line of rails is really quiescent, whether it is not subjected to an opposite acceleration. I reply yes, but what of that? The yield of rail is infinitesimal, but whatever its magnitude it is such as to make the guidance less effective, not more; it is a passive yield to pressure, not an active exertion of energetic work-performing force in the direction of motion or of change of motion. The recoil of a gun is of no assistance in propelling a bullet.

In so far as the rails yield to the train as it enters Euston by a curve, they guide it not to Euston as it was, but to a slightly shifted destination. No matter, they guide it, and they have had no energetic or propelling power whatever.

He asks me further if I fully admit the principle of universal equal opposite reaction, and the consequent conservation of momentum.

Certainly I do; but I do not admit the (as I think) mistaken use Prof. James Ward makes of the principle in the sentence which he refers to.

Mr. McDougall seems to overlook the fact that kinetic energy is independent of direction. Whether a thing be moving north or south or east or west its energy depends on mass and speed alone. To change the speed, work is necessary; no work is needed to alter the direction. Perhaps it may be a help to him, though it is not really important in this connection, if I say that great momentum does not necessarily imply great energy. The momentum of a recoiling gun or earth is equal to that of the projectile, but the energy of the projectile is enormous in comparison with the energy of recoil.

He asks me for an example of "a change of direction of motion of any mass produced without expenditure of energy or opposite change of direction of motion of other mass or masses." But the two things are not the same. An instance of change of direction of motion without expenditure of energy is afforded by the instances we have already taken, or by any perfectly elastic rebound—that of a comet from the sun, for instance. Undoubtedly the sun thereby acquires an equal opposite momentum; but what of that? The modicum of energy in this momentum is infinitesimal, for one thing, and for another it comes from the comet, not from the sun; it renders the rebound less efficient, not more; it is no supply of energy from the central practically stationary mass. The same thing is true of a ball whirling on a string round a pole. When a boy holds the string in an active hand, it is quite easy and usual to do a little work by moving the hand a quadrant in advance of the ball, and thus to maintain, or even increase, its energy; but the force so exerted by a hand is not purely radial, it has a tangential component, and this part of it is effectively propulsive. An energetic, not a passive, centre is needed for that.

[1] "Vorlesungen über Naturphilosophie" (Leipzig, 1902).

Coming to another part of his letter; his illustration of a great display of available energy being brought about by the reversal of motion of one of two similarly flying bodies, suffers from the confusion of energy with available energy. The flying of air molecules, for instance, is in every direction, sometimes so as to be able to collide, sometimes not, but their energy is quite independent of these directional circumstances. As Dr. Hobson truly says in your issue of April 30, "the principle of energy, if applied to even the simplest dynamical system which is possessed of more than one degree of freedom, is, taken by itself, wholly insufficient for the determination of the motion of such system." That is one part of my contention, technically stated. In so far as a question of absolute velocity seems involved in the energy of a single isolated flying mass, I might refer to a discussion of that aspect of the matter in the *Philosophical Magazine* for October, 1898.

In conclusion, I perceive that Mr. McDougall, like some other philosophers, hopes to jump the admitted difficulties of psychophysical interaction by ignoring "matter" altogether and taking refuge in "energy" alone. I venture to predict that those who attempt this will find that though they may wander in dimness for a time, and may cultivate an unawareness of difficulties by failing to see them distinctly, they will not derive any ultimate satisfaction from the blindfolding; nor do I think that they will be well advised to transplant the definite physical term "energy," even though prefixed by a special adjective such as *geistige*, in order to denominate what is probably a perfectly distinct psychical entity with laws of its own. OLIVER LODGE.

THOSE of your readers who have been interested by Sir Oliver Lodge's article printed in NATURE, April 23, on the "Interaction Between the Mental and Material Aspects of Things," may be glad to be referred to Thomas Solly's essay on the Will, published in 1856.

The suggestion of Solly is that every act of the will is simply a guidance of *mental* activity, infinitesimal, indeed, in its amount in each individual act, but such as to influence, not the external world, but the character of the individual exercising it, so that the same external stimulus operates after each successive act of the will on an individual whose character has been changed by that act, whence same stimulus is no longer necessarily the same motive. By thus regarding each act of the will as a "self-determination of the subject," the acts of choice or guidance are assumed to take place in a region of activity about which we have no physical information whatever, and the interactions of material things are left absolutely untouched.

The significance of the suggestion is made extremely clear in Solly's chapter on "Liberty, a Self-Determination of the Subject," and in subsequent chapters, by means of very happily chosen geometrical illustrations.

Mohuns, Tavistock, April 26. A. M. WORTHINGTON.

Mendel's Principles of Heredity in Mice.

THE issues raised in the case of these mice are as yet of such a simple and familiar kind that the source of Prof. Weldon's difficulty is not easy to surmise. When a gamete G bearing albino and pink-eye meets a gamete G′ bearing coloured coat (in this case fawn) and pink-eye, a heterozygote GG′ was produced, with dark eyes and coloured coat. Such hybrids, as the experiments proved, gave off equal

numbers of gametes G, bearing albino with pink-eye, and G′ bearing colour with pink-eye. Consequently from GG′×GG′ we expect and obtain GG+2GG′+G′G′; and from GG′×G equal numbers (approximately) of GG and GG′. So far, GG are pink-eyed albinos; GG′ are dark-eyed with *some* colour in coat; G′G′ are pink-eyed, but with *some* colour in coat.

If we do not consider what *particular* colour GG′ and G′G′ will have, we may treat all gametes G′ as identical. But after crossing with albino such a condition would be unusual. The colour brought in by the original G′ is generally in part resolved, and various sorts of G′ gametes are formed, viz. *a*G′, *b*G′, *c*G′, *abc*G′, &c. Therefore when the hybrids breed together there will be GG′ zygotes of several colours, viz. G.*a*G′, G.*b*G′, G.*c*G′, &c.; also G′G′ zygotes of several colours, viz. *a*G′.*a*G′, *a*G′.*b*G′, &c. Each combination will have its appropriate colour and frequency, though (if the regularity be maintained) all GG′ will have dark eyes and *some* colour, and all G′G′ pink eyes and *some* colour. But as the hybrid produces G gametes equal in number to the various G′ gametes collectively, GG′×GG′ will give on an average one albino in four offspring (experiment gave nine in thirty-seven); and there is no question of one in nine. We are only concerned with *one* hypothesis (that I have set forth in "Mendel's Principles of Heredity," p. 29), and with this hypothesis the published facts are in admirable agreement.

Heterogeneous offspring from crossing two seemingly pure races may seem to Prof. Weldon an "amazing" phenomenon, but it is one with which the breeder early becomes familiar. Even albinos need not be pure or their gametes homogeneous in characters other than albinism.

Grantchester, Cambridge, May 1. W. BATESON.

MR. BATESON reconciles his statements in NATURE of March 19 and April 23 by explaining that in his first letter, when he describes certain mice as of constitution G′G′, he is deliberately denoting a whole series of different gametes by the same name.

The suggested heterogeneity among the gametes of pure albinos is now said to affect characters other than albinism, and is therefore wholly irrelevant. The avowed vagueness in the use of the symbol G′ makes it uncertain whether the fawn-and-white mice are now supposed to produce gametes of different character (with regard to coat-colour and eye-colour) or not. If the gametes of all the fawn-and-white mice used are similar, then all hybrids between these and albino mice are of similar constitution, and the fact that some are yellow, some grey, and some black is left unaccounted for. If the fawn-and-white mice produce even three kinds of gametes, G'_1, G'_2 and G'_3, then on crossing with albinos the hybrids GG'_1, GG'_2 and GG'_3 may be of different coat-colour; but since the fawn-and-white mice always breed true to colour when paired *inter se*, it surely follows that the combinations $G'_1G'_1$, $G'_1G'_2$, $G'_2G'_3$, &c., which arise from such unions (some homozygotes and some heterozygotes) give rise to mice of similar colour. It is this consequence of heterogeneity in a pure-breeding race which seems to me amazing.

In assuming that coat-colour is resolved into simpler elements when hybrids form their gametes, Mr. Bateson follows Mendel; but in such cases Mendel assumes that all the various kinds of gametes, produced by the hybrid, occur with equal frequency, and Mr. Bateson has elsewhere attempted to bring this assumption into relation with the phenomena of cell-division ("Mendel's Principles of Heredity," p. 30). In trying to fit Mr. Darbishire's facts by a Mendelian formula, Mr. Bateson abandons this hypothesis; he now says that a hybrid mouse produces (1) a series of different kinds of colour-bearing gametes, and (2) a number of gametes bearing the characters white coat and pink eye, *equal to the sum of all the other kinds of gametes together*. This departure from Mendel's hypothesis is masked in Mr. Bateson's first letter by the simple device of calling the whole series of different colour-bearing gametes by the same name G′.

Mendel's own view of the way in which compound characters behave gives a maximum possibility of one pure recessive albino among sixteen offspring of hybrids; a non-Mendelian view, lately put forward by Mr. Bateson in another case of colour-resolution (*Proc.* Camb. Phil. Soc., vol. xii. p. 52), gives a maximum of one in *nine*; the view he now suggests for mice gives one in *four*. By modifying first one and then another of Mendel's statements, his name is made to shelter almost any hypothesis, and almost any experimental test is evaded.

In the next number of *Biometrika* Mr. Darbishire will publish a series of new results, which have an important bearing on the application of Mendel's "principles" to his mice. Until these new facts are available, I do not think further discussion will be profitable, and therefore I do not propose to continue this correspondence.

Oxford, May 6. W. F. R. WELDON.

[This correspondence must now cease.—ED.]

INTERNATIONAL METEOROLOGICAL COMMITTEE.

THE International Meteorological Committee appointed by the Paris Congress of 1896 in succession to those appointed by previous congresses, commencing with the Vienna Congress of 1873, will meet this year at Southport during the session of the British Association, September 9 to 16. The committee held a single meeting in the room at the top of the Eiffel Tower in 1900; its last normal session was at St. Petersburg in 1899. It has not met in England for twenty-six years. The original "permanent" committee was appointed by the Vienna Congress in 1873, and consisted of six members under the presidency of Buys Ballot; its successor now numbers seventeen members, representing a large number of the official meteorological organisations of the world. Prof. Mascart, of the Bureau Central Météorologique of France, is president, and Prof. H. H. Hildebrandsson, of the Royal Observatory of Upsala, is secretary, having been elected to that office on the resignation of Mr. Scott, who was secretary from 1874 (the Utrecht meeting) until the close of 1899. The other members are Prof. von Bezold (German Empire), Prof. Billwiller (Switzerland), Captain Chaves (Azores, Portugal), W. Davis (Argentine), Sir J. Eliot, K.C.I.E. (India), Prof. S. Hepites (Roumania), Prof. H. Mohn (Norway), Prof. Willis L. Moore (United States), Prof. L. Palazzo (Italy), Prof. Paulsen (Denmark), Prof. J. M. Pernter (Austria), Mr. H. C. Russell, C.M.G. (Australia), General Rykatcheff (Russia), Mr. W. N. Shaw (Great Britain), and Prof. H. Snellen (Holland).

The functions of the committee are to discuss meteorological questions of international interest and formulate proposals for international cooperation in connection therewith. The deliberations have an official character in virtue of the committee being appointed by a congress of representatives delegated in response to an official invitation of one or other of the European Governments, but the committee has no executive authority. It has been the practice for the committee to appoint from time to time various "commissions" or subcommittees to prepare reports upon questions that require preliminary discussion. The members of these subcommittees are not necessarily members of the international committee. They meet from time to time on the invitation of their respective chairmen, and opportunity is often taken of the occasion of the meeting of a subcommittee to obtain more general discussion by inviting other persons interested in the special subjects to take part in the proceedings, and sometimes to become members of the subcommittee. There are at present five subcommittees, constituted as follows:—

(1) *Terrestrial Magnetism.*—Sir Arthur Rücker (chairman), Messrs. Litznar, Moureaux, Palazzo, Paulsen, von Rijkevorsel and Rykatcheff.

(2) *Radiation and Insolation.*—Prof Viollo (chairman), MM. Angstrom, Chistoni, Chwolson, Snellen, Stupart, and Tacchini.

(3) *International Weather Telegraphy.*—Prof. J. M. Pernter (chairman), Messrs. Billwiller, Mohn, von Neumayer, Rykatcheff, Snellen, Tacchini.

(4) *Cloud Observations.*—Prof. H. H. Hildebrandsson (chairman), Messrs. Mohn, Riggenbach, Rotch, Rykatcheff, Sprung, and Teisserenc de Bort.

(5) *Aëronautics.*—Prof. H. Hergesell (chairman), MM. Assmann, Erk, de Fonvielle, Hermite, Jaubert, Pomortzeff, and Rotch.

To the last mentioned the following names have been provisionally added by cooptation:—Messrs. Berson, Angot, Bouquet de la Grye, Cailletet, Rowanko, in 1898; Prince Roland Bonaparte, Tacchini, Teisserenc de Bort, Hildebrandsson, Pernter, Hinterstoisser, Moedebech de Sigsfeld, in 1900, and others in 1902.

The subcommittee on terrestrial magnetism held a very successful meeting at Bristol during the session of the British Association in 1898. All the subcommittees met in Paris in 1900, and the aëronautical committee met in Berlin in 1902. The subcommittee on cloud observations has completed its work for the time being, and Prof. Hildebrandsson's report has just been published.

The subcommittee upon weather telegraphy will meet at Southport, but information as to proposed meetings of other subcommittees is not yet forthcoming.

Two conspicuous considerations point to the forthcoming meeting of the committee as one of exceptional interest and importance. The first is meteorological. The situation of the British Isles with regard to the Atlantic must necessarily attract the attention of all meteorologists. The problems which that situation brings into prominence are doubtless among the most difficult, but at the same time the most interesting of meteorological inquiries. The second is economical or social. This country is a great centre for communication with all parts of the globe, and in spite of, or perhaps because of, its insular position, is easy of access from all quarters. There are, therefore, good grounds for expecting that the hospitality of the British Association and of Southport will result in a meeting of unusual interest as regards meteorology and the kindred sciences.

No programme of proceedings has yet been issued. The executive meetings of the committee must necessarily be exclusive, but opportunity will be afforded for the discussion of meteorological questions of general interest in connection with the meetings of Section A, as was the case with the magnetic subcommittee at Bristol. Among the new subjects which will come before the committee may be mentioned the special question of the relation between meteorology and solar physics, the discussion of which it is hoped may be initiated by the president of the British Association.

Southport has special appropriateness for such a meeting. Its meteorological establishment, the Fernley Observatory, under the direction of Mr. J. Baxendell, is a conspicuously successful example of municipal enterprise in that direction. In connection with the meeting, provisional arrangements have been made for an exhibition of novel meteorological appliances and other objects of meteorological interest. A committee representing the Meteorological Council, the Royal Meteorological Society, and the Scottish Meteorological Society, with some additional members, has been formed to carry out the arrangements.

MAORI ART.[1]

NOT only students of Maori ethnography, but those who are interested in artistic technology, will heartily congratulate Mr. A. Hamilton on the completion of his great work on "Maori Art." Although this magnificently illustrated monograph nominally deals with decorative art, it is by no means confined to that subject, as for many years Mr. Hamilton has been diligently collecting facts and illustrations which bear on the social life of the Maories. Many interesting customs have been omitted as being beyond the scope of the work; usually only those matters are considered which are connected more or less closely with objects which are capable of being figured. Not too soon has Mr. Hamilton applied himself to his labour of love; constantly throughout the book do we find uncertainty as to the exact significance of patterns and designs, and occasionally objects are figured of which the use or meaning is very doubtful. Nor is this indefiniteness due to lack of energy on the part of the author; it is merely another example of the great change that is so rapidly modifying the majority of backward peoples. "How much interesting information," Mr. Hamilton writes, "has been lost can be estimated by the fragments which have been gathered. The system of laws for the government of the body politic known as *tapu*, was the outcome of centuries of experience of practical socialism. However irregular, capricious, and burdensome it may now appear to have been, it was certainly the source of order to them, and was of great use to conserve them as a race, and to sharpen their intellectual and moral faculties, besides retaining the canon of art in its native purity. As Mr. Colenso points out, when all this was swept away, together with polygamy and slavery, without anything to replace them, the nation, as a people, was broken up. 'However distasteful,' he says, 'these three things might be to an European and Christian, they were the life of the New Zealander. They were, perhaps, the three rotten hoops round the old cask, but they kept the cask together.'"

The work consists of five parts, of which the first part contains an account of Maori canoes, with ten plates. Part ii. deals with Maori habitations, with diagrams of the construction of a house, plans and sections of a fortified *pas*, with fifteen plates, and a valuable essay by the Rev. Herbert Williams on Maori rafter patterns, illustrated by twenty-nine coloured examples; these have never been described, and therefore the explanation of Mr. Williams of the patterns is doubly welcome. The weapons and tools are described in the third part, and are illustrated by eleven plates. The fourth part deals with dress and personal ornaments, with fifteen plates. The final part is devoted to the social institutions of the Maori people, with descriptions of their games, amusements, and musical instruments, with thirteen plates. Each of the sixty-four plates contains illustrations of several objects, and there are numerous figures in the text, so that the total number of illustrations is very large, and all of them are of excellent quality and constitute a mass of information for the ethnographer, and a wealth of material for the student of art. A noticeable feature of each part is the list of words relating to the subject-matter of that part, which forms a valuable subject vocabulary, which will prove of great use to students.

The wood-carving of the Maories is very characteristic, as regards both technique and *motive*. The designs are carved with great boldness, considerable relief is employed, and the background is usually filled up with labyrinthine designs, the spaces of which are

[1] "Maori Art." By A. Hamilton. Pp. 439; 64 plates and numerous illustrations in the text. (New Zealand Institute, Wellington, N.Z Price 4*l*. 4*s*.

frequently perforated. The most common form of surface decoration consists of ridged parallel lines enclosing narrow bands or areas, which are filled up with short cross-ridges, as in Fig. 1, less frequently notched ornamentation, called *taratara o kai.*

The carvings most frequently represent grotesque human figures, often associated with a problematical creature called *manaia* (Fig. 2). Concerning the *manaia*, Mr. Hamilton says:

"On the slab are carved representations of a human figure attended by the monstrous bird or snake-headed figures so frequent in all carvings from the northern portion of New Zealand. At present no explanation is forthcoming of the esoteric meaning of these mystic

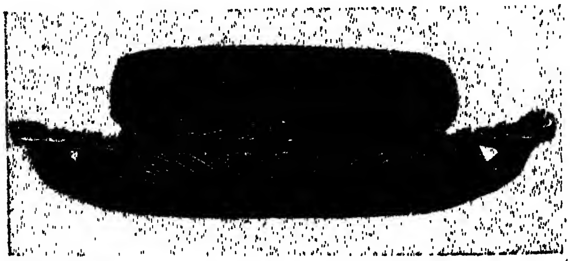


FIG. 1.—*Waka*, or box for holding greenstone ornaments or feathers for the hair.

figures. To advance a theory on the subject without ascertained facts from the *tohungas* (priests) of old would only add to the difficulties of the interpretation. Earle says, 'One of their favourite subjects is a lizard taking hold of a man's head, their tradition being that this was the origin of man.' Possibly these *manaias* may have been considered as representations of lizards. In Samoa *manaia* is the name of a lizard." Pratt, however, in his "Grammar and Dictionary of the Samoan Language," third edition, 1893, gives *manaia* as "fine-looking, handsome; a good-looking man." The interpretation of this *motive* is greatly to be desired, as it is evidently one of great antiquity and importance. Mr. J. Edge Partington has several

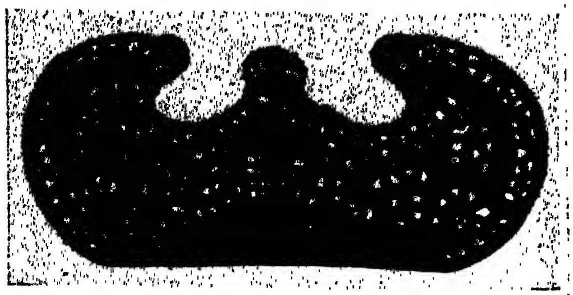


FIG. 2.—Carved *Pare*, or door ornament representing a man, with *manaia* on each side of him.

times attacked the problem (*Journal* Anthrop. Inst., xxix. p. 305; xxx., *Miscellanea*, Nos. 40, 41; *Man*, 1902, No. 17). He believes it to be a lizard, or perhaps a water-snake. The present writer has hazarded the view (*Man*, 1901, No. 55) that it may be a degraded and conventionalised representation of a bird, probably of the sacred bird of the West Pacific, the frigate bird which possesses *mana* (spiritual or magical power) in an eminent degree. The Maori spiral is also called *manaia*, and it appears to be related to the problematical animal. The spiral *manaia* and the less conventionalised *manaia* are associated with human beings on the carvings of the store-houses, and some of these human beings are so grouped as to indicate that they symbolise fertility. It is possible that the *manaia* originally, directly or indirectly, had a similar meaning. If this be so, it would seem as if the carving on these store-houses was a magical formula to ensure the abundance of the crops. Unfortunately, Mr. Hamilton merely says, "the *pataka* was the treasury, and its adornments were not only elaborate and beautiful, but had special significance" (p. 90).

A considerable amount of work yet requires to be done before we can feel that we really understand the symbolism of Maori carvings and the meaning of all the patterns. It cannot be too often or strongly insisted upon that this work cannot be accomplished in European museums; it is necessary for researches to be made on the spot. Let us hope that it be not yet too late.

It seems rather ungenerous to find fault with Mr. Hamilton after all the pains he has taken, but the reader would have been saved trouble if the author had been more careful in his editing. For example, it most frequently happens that the plates on which objects are figured are not referred to in the descriptive text, and *vice versâ*; thus the reader has to hunt through the pages to find the appropriate illustration or description, as the case may be. Sometimes the same class of object is figured on plates some distance apart, and still more troublesome is the case of the illustrations in the text. It is true there are lists of specimens figured in the plates and of illustrations in the text, but the continual turning the pages backwards and forwards to consult these as the text is being read, and the subsequent looking up the illustration, is apt to try the reader's patience.

The study of comparative decorative art will gain greatly by the publication of this work, and we echo the author's expression of sincere thanks to the Board of Governors of the New Zealand Institute at Wellington, N.Z., who have carried out the publication of so costly a work. Messrs. Fergusson and Mitchell, the publishers of Dunedin, also deserve great credit for the beauty of the illustrations and the excellence of the typography.

A. C. HADDON.

THE LONDON EDUCATION BILL.

THE Bill to extend and adapt the Education Act, 1902, to London, passed its second reading on Wednesday, April 29. As was pointed out in the issue of NATURE for April 9, the Bill was introduced by Sir William Anson on April 7, and in referring to the first reading proceedings we summarised its main provisions. As a result of the representations of educationists of different shades of political opinion on the Bill in its present form, the Government made it sufficiently clear during the course of the second reading debate that they were prepared to introduce modifications during the passage of the Bill through the Committee stage.

The central principle of the Bill was defined by the Prime Minister during the second reading debate; it is intended to provide that there shall be a central education authority and other local authorities to which certain powers can be delegated. The central authority is to be the London County Council, and the bodies to which delegation takes place are to be the borough councils. The vote on the second reading affirmed this principle by a majority of 137—163 voting for an amendment that the Bill be read a second time that day six months, and 300 against.

When the Bill is interpreted in the light of what Mr. Balfour has laid down as its fundamental principle, it becomes clear that modifications in its provisions are of great importance, and it is instructive to study the

question from this point of view. First, then, as regards the constitution of the central authority; it is proposed that the new Education Committee for London shall consist of ninety-seven members, of whom thirty-six shall be members of the London County Council appointed by that authority; thirty-one shall be members of the councils of metropolitan boroughs appointed by those councils, Westminster and the City of London appointing two each, and each of the other metropolitan boroughs appointing one member; twenty-five are to be co-opted members representing expert educational opinion, and including representatives from such institutions as the University of London, the City Guilds, the City Parochial Charities, and so on; and for the first five years five members of the existing School Board. The question is, Do these proposals provide for the election of a central education authority on which the London County Council, which has the sole rating power, will have paramount influence? The majority of competent judges think not. There seems no good reason forthcoming for the inclusion of representatives of borough councils, and it is hoped that a change in this connection will be made in Committee. This is the more probable, too, as the proposed education committee is too unwieldy, and will from its size be likely to encourage general debate on educational questions rather than specific and intelligent administration of the work of the schools.

Then there is the question of the duties of the borough councils in their capacity of local authorities with delegated powers. The Bill makes these councils "managers of all public elementary schools provided by the local education authority within their borough," and gives them the appointment and dismissal of teachers in these schools and the custody of the buildings. They are to have, too, the selection of sites for new school-buildings. It is to be hoped that the clauses of the Bill dealing with the duties of borough councils will be greatly changed. It is highly undesirable that the teacher should be regarded as the servant of the local rather than of the central authority, and it is a mistake to run the risk of a lowering of the efficiency of the elementary school teachers in the metropolis by allowing the possibility of local prejudices, relationships, wire-pulling, and what not, to influence the selection of teachers. The London School Board has secured the reputation of having selected its teachers on their merits, and it would be a great mistake to make it possible for the teaching in any London borough to deteriorate because its councillors chose teachers from personal considerations rather than on the score of efficiency. So, also, in the case of the selection of sites for new schools; the central authority would undoubtedly choose these because of their suitability for the purpose; the local councils might conceivably select them for quite other reasons, for example, because a prominent councillor with great influence on the council wished to sell. These points require very careful consideration, and it may be safely predicted that during its passage through Committee the Bill will undergo considerable modification in these directions.

But from the point of view of readers of NATURE it is more important to consider the extent to which the provisions for higher and secondary education contained in the Act of last year are affected by the Bill now before the House of Commons. The present Bill being intended to extend the Act of last year to London, it is clear that the conditions which apply to the rest of the country, so far as secondary and higher education are concerned, are also to hold good in London. The Act of last year repealed the Technical Instruction Acts, and as a consequence the old technical instruction committees are disappearing, and their duties are being taken over by the new education authorities. The same thing will, on the passing of the London Education Bill, take place in London. The present Technical Education Board of the London County Council will be merged in the new central education authority which is to be set up, and from this consideration it is of paramount importance that this new authority should be guided by the same broad principles and actuated by the same lofty ideals as the present Technical Education Board has been. The existing board, with its absence of mere local characteristics, has done excellent work for the secondary and higher education of London, and on these grounds alone the introduction of any local element is to be deprecated.

As Sir Michael Foster said during the second reading debate, the University of London and the new education authority must work together for the better education of the people of London, and the new authority must be interested in university as well as in secondary and elementary education. It may be admitted that the new authority should be interested in all kinds of education from beginning to end, and should be prepared to give generous financial aid to education of university type, but there is a danger in admitting this generalisation which must be avoided. There must be nothing in the direction of delegating powers of managing higher education to local bodies of any kind. University education is in a very real sense a question of national importance. It must be guided by men of culture with the broadest possible catholicity. Education may be one and indivisible, just as London itself must be regarded from the point of view of its education, but the men who are competent to look after the schools of elementary grade are not the persons in whose hands the guidance of higher education may with advantage be left. Because every scheme of higher education depends for its success on the existence of youths possessing a sound general education, no efforts should be spared to secure a satisfactory system of secondary and elementary education in London and the country generally, but it must be persistently remembered that this is but a means to an end. Our boys must be satisfactorily educated, chiefly because without this preliminary training it is impossible to obtain a supply of properly qualified students for our universities and colleges, where, somehow, our manufacturers and merchants must be trained in such a way as to enable them to hold their own with the highly qualified competitors to be found in Germany and America.

It would be an excellent thing for London and for the country if well-equipped and highly endowed university colleges could be provided in several parts of the metropolitan area. But though every effort should be made to ensure the active interest of the local municipal councils in the work of such institutions, their management and government should in no sense be of a purely local nature. There should be a real connection with the State as indicating the national importance of university education, a due representation of existing great universities to enable the colleges of the metropolis to benefit by experience gained in other centres, and also members of the governing body elected by the corporations and persons contributing to the endowment funds.

Thus to point out the disadvantages of saddling university colleges with governing bodies actuated with parochial sentiments is surely quite enough to discourage the supporters of such a policy, and amply sufficient to convince everybody that the most strenuous efforts must be made in a contrary direction. It is only necessary to try to imagine the outburst of ridicule and

indignation which would greet the suggestion that the government of the Universities of Oxford and Cambridge should be placed in the hands of the municipalities of Oxford and Cambridge respectively to see how indiscreet is a proposal made during the second reading debate to give the control of "all kinds of education from the beginning to the end" to the new Education Committee for London. Such an authority will have at least quite enough to do in building up a properly coordinated and duly unified system of secondary and elementary education, and in continuing the excellent work now being done by the London Technical Education Board. It would be in the highest degree unwise to give the new authority any sort of opportunity to interfere, for example, with the procedure of the Senate of the University of London, though, as has been said, it should be made possible for the new committee to show its sympathy with higher education by contributing to the funds of the University of London and of the metropolitan university colleges.

The university college cannot in any narrow sense be a local institution. To attempt to make it so would be the work of an enemy to higher education; indeed, it would be difficult to imagine anything more likely to play into the hands of our competitors than a disposition to place university education under the control of local authorities. Germany, for instance, would probably be highly delighted if this were done.

At present higher education in the United Kingdom largely depends upon private munificence and upon financial aid from municipal authorities. But, when the Government and the people of this country have been educated to understand that the maintenance of universities on a generous scale is of prime importance to the nation's well-being, it will become evident that the only satisfactory solution of a difficult problem is to regard the adequate provision of higher education as an important function of the State. When this is properly appreciated, the universities will be dependent upon State grants alone; they will no longer find it necessary to solicit financial help from individual munificence, or to secure the voting interest of local councillors with the object of obtaining municipal aid.

NOTES.

AT the closing ceremony of the fourteenth International Congress of Medicine, it was announced that the prize of 5000 francs offered by the Moscow municipality had been allotted to Dr. Metchnikoff, of the Pasteur Institute, Paris, and the prize of 3000 francs offered by the Paris municipality to Dr. Grassi, of Rome. The fifteenth congress will be held in Portugal in 1906, when the president will be Prof. Coimbra Costa. Dr. Miguel Bombarda, who will be the general secretary of this congress, is a member of the Royal Academy of Sciences and president of the Royal Academy of Medical Sciences at Lisbon.

THE death is announced of M. Worms de Romilly, formerly president of the French Physical Society, and a member of the committee of the International Association of Electricians.

PROF. E. RAY LANKESTER, F.R.S., has been added to the departmental committee appointed to investigate experimentally and to report upon certain questions connected with the dipping and treatment of sheep.

DR. ROBERT BELL, F.R.S., acting director of the Geological Survey of Canada, is at present in England for the purpose of receiving personally the degree of Doctor of Science which is to be conferred upon him to-day by the University of Cambridge. Dr. Bell was promoted to the directorship of the Canadian Survey more than two years ago, after being associated with the survey department for forty-six years, but it will surprise all who are not familiar with official routine to know that his appointment has not yet been gazetted, and we presume, therefore, that he does not receive the pay of the appointment.

LADY HUGGINS and Miss A. M. Clerke have been elected honorary members of the Royal Astronomical Society.

THE International Association of Botanists has just held its first congress at Leyden under the presidency of Prof. Goebel, of Munich.

THE *Athenaeum* announces the death of Josef Enzenberger, the director of the scientific station of the German South Pole Expedition. Herr Enzenberger was only thirty years of age.

MR. W. H. PATCHELL has been appointed a member of the committee to inquire into the use of electricity in mines in the place of Mr. James Swinburne, resigned.

THE honorary treasurer of the Cancer Research Fund, under the direction of the two Royal Colleges of Physicians and Surgeons, has received the sum of 1000*l*. from Mr. H. L. Florence for the advancement of the investigation of cancer.

THE *Times* correspondent at Wellington, N.Z., points out that unless the next season should prove more favourable than the last, the *Discovery* will remain fast in the ice, and her ultimate abandonment in the Antarctic is possible. It is imperative, therefore, that the relief ship should return.

SOME additional particulars referring to the British Antarctic Expedition have been brought from New Zealand by the s.s. *Paparoa*, which arrived at Plymouth on Sunday with a member of the *Discovery's* crew, and also one of the crew of the relief ship *Morning*. A remarkable experience is related by a young New Zealander named Hare, who set out from the *Discovery* with a party of officers and men to deposit a record at Cape Crozier. He was separated from the party when returning to the ship, and was buried in a snowdrift. After being asleep in the snow for thirty-six hours he was revived by the warmth of the sun, and was strong enough to rise out of the snow and walk to the ship. With reference to some of the work in terrestrial physics, Mr. Bernacchi says in a letter:—"One of the most typical of the magnetograms for the year 1902–3, with *data* for reduction, has been sent home in case something should happen to us before the return of the expedition. The seismograph has been working the whole year, but very few shocks and tremors are recorded. Our largest are on May 25 and on September 22, which seems to correspond with your record on April 18. There are some irregularities in the line which might be due to the Guatemalan earthquake. There are some tremors, however, which coincide with your record. From October 3 to October 8 a great many tremors were recorded. I also have a year's observations of atmospheric electricity."

IN connection with the celebration of the centenary of Dalton's enunciation of the atomic theory, to be held at Manchester next week, the following extract from the presidential address delivered by Prof. J. Emerson Reynolds, F.R.S., to the Chemical Society, at the last anniversary meeting, is of interest:—"This year is the centenary of the announcement, in a tentative form, of probably the most fruitful and valuable of all scientific hypotheses—Dalton's Atomic Theory. On October 21, 1803, Dalton read a paper

"On the Absorption of Gases by Water and other Liquids" before a select audience of nine members of the Literary and Philosophical Society of Manchester. He appended to that paper a statement which, according to Sir Henry Roscoe and Dr. Harden ('A New View of the Origin of Dalton's Atomic Theory,' Macmillan, 1896), is the first published indication of the atomic theory, though the paper was not circulated in the Manchester *Memoirs* until November, 1805. Thus, just 100 years ago, the conception of the discrete nature of matter was formulated, and used to explain the facts then known as to the constant composition of chemical compounds, and the laws discovered by Dalton as to their formation in definite and multiple proportions. This germ of the molecular theory of matter, which now pervades all thought in chemistry and physics, arose, as Nernst truly says, 'by a single effort of modern science, like a Phœnix from the ashes of the old Greek philosophy.' Therefore, physicists as well as chemists are interested in an event of the highest significance in the development of both branches of science. I am glad to know that a special celebration will shortly be held in that great city which claims Dalton as her illustrious son."

The Rumford premium of the American Academy of Arts and Sciences, consisting of a gold and a silver medal, has been awarded to Prof. George E. Hale, director of Yerkes Observatory, in recognition of his researches in solar and stellar physics, and in particular for the invention and perfection of the spectroheliograph.

An International Exhibition of Hygiene, Life-saving, Sports, Fishery, and Ambulance is to be held in Paris from September to November, 1904, at the Grand Palais des Champs-Elysées. Full particulars may be obtained on application to the Commissaire Général, Exposition Internationale de 1904, 3 rue des Moulins, Paris.

The *Lancet* reports that a new building is to be erected in Manila to provide laboratory space for the chemical and biological laboratories and the serum institute. The building will be divided into sixty rooms, and will be 216 feet long and 60 feet wide, having two storeys. The plans of the building have been drawn so as to accommodate all the work within one building, one half of which will be occupied by the chemical and the other half by the biological laboratory.

We learn from *Science* that Harvard University, New York University, and the Bermuda Natural History Society unite in inviting botanists and zoologists to spend six weeks in the temporary biological station provided at Bermuda. The two possible dates of sailing from New York are June 20 and July 4. Circulars and detailed information will be supplied on application either to Prof. C. L. Bristol, University Heights, New York City, or to Prof. E. L. Mark, 109 Irving Street, Cambridge, Mass.

We learn from the *British Medical Journal* that the Croonian lectures before the Royal College of Physicians of London will be delivered this year by Dr. C. E. Beevor on June 9, 11, 16 and 18. The subject will be muscular movements and their representation in the central nervous system. The first course of FitzPatrick lectures will be delivered by Dr. J. F. Payne on June 23 and 25. He has chosen for his subject "English Medicine in the Anglo-Saxon and Anglo-Norman Periods."

A correspondent points out that in each of the embroidered designs reproduced in a notice of East Siberian decorative art (April 16, p. 560) it is possible to distinguish a man's face quite as clearly as the conventional cocks which are supposed to be grouped about the central axis.

A congress commemorative of the fiftieth anniversary of the foundation of the Royal Photographic Society will be held next week. The congress will be opened on Tuesday, May 19, at the New Gallery, Regent Street, at 8.30 p.m., when the president will deliver an address. This will be followed by a conversazione, when the president, Sir William Abney, and council will receive the Society's members and guests. On Wednesday, May 20, at the Society's house, there will be a meeting at which papers will be read, and in the evening there will be a dinner. In connection with the congress there will be a special exhibition at the Society's rooms of objects having interest in the history of photography. The council hopes that this exhibition will represent the various stages of photography from its infancy to the present day. The commemoration of the jubilee will not cease with the congress of which details are given above. It is intended that the annual exhibition shall be distinguished by features which will mark the present year as one of more than usual significance. There will be a special invitation pictorial section in addition to the established pictorial section, and the scientific and technical section will be entirely collected by direct invitation, both having for their object the illustration of the progress and present position of photography.

On May 5 Lord Avebury, the president of the Selborne Society, took the chair at the annual meeting and conversazione. He alluded to several of the many lines of work upon which the association is engaged, to wit, the interest which it is taking in the Home Counties Nature-Study Exhibition, the bird sanctuaries arranged for, and the protection of plants. Lord Avebury claimed that near London plants now needed more looking after than birds, and quoted instances from his own experience; he also pointed out how easy it was for country clergymen to follow in the steps of the great Gilbert White. Sir John Cockburn also alluded to plants and the advantage of the study of flowers to children, saying that in this respect we might all well be children. As chairman of the Nature-Study Exhibition held last year, he wished all success to the new undertaking mentioned by Lord Avebury. Sir George Kekewich said that of all the objects of the Selborne Society, he would put nature-study first. Dr. Bowdler Sharpe gave an illustrated lecture on Selborne, and Mr. Andrew Pears, who recently bought the Wakes, offered a cordial welcome to the members of the Society who are to visit Selborne in June next.

The freedom of the city of Rome was conferred upon Mr. Marconi last Thursday by Prince Colonna, Syndic of Rome. The occasion was marked by much enthusiasm; a conference was held in the afternoon and a banquet in the evening, and from all sides Italians welcomed the opportunity of doing honour to their distinguished countryman. Since then Mr. Marconi has been conducting experiments in Rome and the neighbourhood with, it is reported, very successful results; before leaving Rome he intends to select a site for the high-power station which is to be erected near the city.

Telegrams from Ottawa state that Mr. Fielding, Dominion Minister of Finance, speaking in the House of Commons with reference to the Marconi system, said that the system had not been as successful as had been expected, and that the Government did not propose to make any further contributions towards it. It will be remembered

that last year the Canadian Government made a contribution of more than 16,000*l.* towards the cost of establishing Transatlantic communication. The Canadian Government is, however, still confident of the ultimate success of the system. The delay in getting the Canadian station into successful commercial operation is said to be due merely to a breakdown of a mechanical nature. It seems as if some other difficulties are also being encountered, as one does not hear of any Transatlantic signalling from either of the two American stations.

THE Great Western Railway, following the examples of the London and South Western and North Eastern companies, has decided to run automobile cars on some sections of its line. This method of providing for a more frequent service has been necessitated by the competition of electric tramways, and affords further evidence in support of the view that electric traction is likely to bring about in time a complete revolution in our methods of locomotion. The motor-cars to be used by the Great Western are to be steam driven. A notable feature of the scheme is that provision is to be made for frequent stoppages between the stations to pick up passengers; it is proposed that the cars should stop at all the level crossings—of which there are four on the section between Chalford and Stonehouse, where the first experiment is to be made—and also, if it is feasible, at any points at which foot-paths give access to the line. It is hoped in this way to organise a successful competition with the electric tramway which has been projected and sanctioned parallel to this part of the line. The superiority of electric traction for working of this kind is so well known that one may reasonably expect the Great Western Railway will find it advisable before long to get rid of the steam motor-cars and provide for electrical working over the section, which may pave the way, in the manner that many have prophesied, for the ultimate complete conversion from steam to electricity.

THE electrification of our steam-driven railways proceeds apace; the inauguration of the electrical working of the Mersey Railway, which took place a few days ago, is an event which will probably before long be paralleled by many similar inaugurations all over the country. To the Mersey Railway then belongs, we believe, the honour of being the first steam railway in Great Britain to undergo conversion. Special conditions have in this case hastened the change; the long tunnel under the river made a frequent train service impossible without expensive outlay in ventilation, which the company could not afford. Electrical working was therefore decided upon in 1900, and a contract made with the British Westinghouse Co. to carry out the conversion in July, 1901. In considerably less than two years the work has been completed, in spite of the fact that it involved relaying the whole of the five miles of permanent way, together with putting down the two additional lines of rails to serve as conductors (an insulated return being used) and the erection of a power-house and plant, &c. The tunnel has been cleaned and lighted throughout, and electric lighting installed at all the stations; electricity has, in fact, been adopted for almost every detail of the working. A good deal of the work is naturally of American design, and some of it of American construction. It is to be hoped that as we hear more of other railways being converted, we shall hear less of their using foreign machinery; it is probably inevitable that in the not very distant future our whole railway system will be "electrified," but it is not necessary that this word should be synonymous with "Americanised."

WE regret to announce the death last week of Mr. Clarence Bartlett, who only recently retired from the post of superintendent of the Zoological Society's Gardens in the Regent's Park, which he had held since the death of his father, whom he succeeded, in 1897. Mr. Clarence Bartlett was the second son of Mr. A. D. Bartlett, and was, we believe, brought up in the service of the Zoological Society. During the early "sixties" he was appointed assistant superintendent (and subsequently clerk of the works) to the Gardens, and in 1866 he was dispatched by the council to Surinam to bring home a young manati, which died a few hours before the vessel arrived at Southampton. A more important mission fell to his lot in 1875, when he was granted special leave by the council in order to accompany, as zoological collector, His Majesty the King (then Prince of Wales) to India. From this tour he returned the following year, bringing home in first-rate condition a large number of living mammals and birds, which were housed in the Society's Gardens. Among these was the elephant "Jung Pershad," which lived for many years in the menagerie, and the mounted skin of which is exhibited in the Natural History Museum, where, by the way, it has just been transferred from the zoological to the geological department, in order that it might stand side by side with the skeletons of its extinct relations. Mr. Bartlett appears never to have contributed anything to the scientific publications of the Society. Soon after the resignation of the secretary in the autumn of last year, ill-health and other reasons rendered it advisable that Mr. Bartlett should retire on a pension, but when he left his house in the Gardens it was apparent to all that he had little prospect of living to enjoy this reward of his services.

THE Parliamentary Report of the Meteorological Council for the year 1901–2 has recently been issued in the same form as in the previous year. Among the appendices we find (1) correspondence with the London County Council respecting an inquiry into the occurrence and distribution of fogs in London; the report of the inquiry has been already published. (2) A comprehensive statement of provisions for the supply of information to the public; and (3) an interesting summary of conspicuous meteorological occurrences (with two plates). An application was received from the Royal Meteorologieal Society to assist in providing means in carrying out experiments on the exploration of the upper air by means of kites. In order to facilitate this important investigation the Council agreed to provide the instruments for the establishment of a base station. At the request of the Registrar-General the Council has undertaken the supply of meteorological tables for his weekly, quarterly and annual reports which had been for many years satisfactorily prepared by Mr. James Glaisher, at great personal labour. A considerable number of returns has been received through the Foreign Office from African Protectorates, and the Council has under consideration the publication of an annual summary of the observations from these and other colonial stations; the reduction and tabulation of these important data will entail much additional work and expense. In order to meet the constantly increasing demands upon the public usefulness of the department, both as regards land and ocean meteorology, some revision of the organisation of the various branches has been necessary, including the opening of the office at 8 a.m. for the service of meteorological telegraphy; the Parliamentary grant, however, remains at the same figure as heretofore.

MR. THOMAS H. MEANS, of the U.S. Department of Agriculture, was recently sent to Egypt by the U.S. Secretary

of Agriculture to investigate and report upon the methods of reclaiming alkali lands, with particular reference to the conditions in America. The abandonment of many acres of once fertile land at the time of the Arabian conquest, and the change from the annual flooding to the perennial system of irrigation through canals, has caused the rise and spread of alkali over vast areas in Egypt. The reclamation of large tracts of this kind is being taken up as a business enterprise by British engineers, and the work has proved a large financial success. The conditions met with and the methods used are set forth by Mr. Means in *Bulletin* No. 21 of the Bureau of Soils, U.S. Department of Agriculture.

IN the New Year's number of NATURE there appeared an account of a basil, *Ocimum viride*, a plant which is known to the natives of Nigeria as a protection against mosquitoes. Captain Larymore, by whom this information was first obtained, in a recent letter to the *Times* mentions that he has brought home a plant which he has presented to the authorities of the Kew Gardens, and that it may be seen there. He also states that the natives believe in its efficacy when taken as an infusion in cases of malarial fever. Further evidence is offered in another letter to the *Times* by Sir George Birdwood as to the knowledge widely spread among the Hindus of these qualities of the basils, which occur wild, and are generally cultivated in India. Thus, during the formation of the Victoria Gardens in Bombay, the workmen were attacked both by mosquitoes and malaria, when upon the recommendation of the Hindu manager basil plants were placed round the gardens, with the result that the unhealthy nature of the locality was effectually changed.

PROF. HOYLE (*Manchester Memoirs*, vol. xlvii. No. 9) points out that the cuttle-fish described as *Loligo eblanae* is identical with the one subsequently named *Todaropsis veranyi*, consequently the name of the species should be *T. eblanae*.

IN the January issue of the *Proceedings* of the Philadelphia Academy Messrs. Anderson and Grinnell draw attention to the birds of the Siskiyou Mountains, California, on account of the fact that they exhibit a mixture of types characteristic of two distinct faunas, namely, the moist coast fauna and the dry Sierran fauna.

FROM a distributional point of view, the occurrence in the Philippines of an indigenous representative of the Australasian gum-trees is a matter of considerable interest, and it is therefore satisfactory to find that, according to Mr. J. H. Madden (*Proc.* U.S. Nat. Mus., No. 1327), *Eucalyptus nandiniana*, which is typically from New Britain, also occurs in the aforesaid islands.

AMONG the articles in the *Journal* of the Quekett Microscopical Club, attention may be directed to one by Mr. W. H. Harris on the "dentition" of flies. Although the various forms assumed by the "teeth" of these insects have not escaped investigation, they seem to have attracted but little attention in this country, and the author has therefore done well in pointing out the possibilities of this branch of study. An excellent plate accompanies the paper, in the course of which Mr. Harris expresses some doubts as to whether the true function of the canals known as pseudotracheæ is to convey liquid-food.

THE position in which different birds carry their legs in flight forms the subject of an interesting paper by Captain Barrett-Hamilton in the *Zoologist* for April. In all birds it appears that the tibia, during continuous flight, must occupy a nearly horizontal position, pointing directly backwards. The position of the metatarsi, on the other hand, depends on whether the legs are required to act as a rudder. During flight, birds must have an efficient rudder, and in cases where the metatarsi are very long, as in the heron, and must of necessity be directed backwards, the legs serve this function. On the other hand, in many strong and rapid flyers, especially those which make sharp turns and twists, the steering is effected by means of a long, and frequently forked, tail. Captain Hamilton gives a list of birds exhibiting these correlations, but points out that our knowledge of the subject is still very imperfect, and that careful observation of a large number of species is required. With the exception of the kites and fork-tailed kites, the birds of prey form an exception to the rule.

A USEFUL summary of our present knowledge of leprosy, its ætiology and prophylaxis, is given by Mr. George Pernet in the April number of the *Quarterly Review*. The author discusses the introduction into, and prevalence of, leprosy in the British Isles in the middle ages, the effects of the segregation of lepers, the characters of the disease and of the leprosy bacillus, and the danger of the introduction of the disease into other countries through the importation of coolie, Chinese, or other labourers belonging to races afflicted with this scourge.

AN important report upon the ætiology and pathology of beri-beri has been published by Dr. Hamilton Wright. A specific organism has so far not been discovered, and Dr. Wright has also failed to isolate one. His theory of the nature of the disease is that it is due to a specific micro-organism which remains dormant in certain localities, but that, having gained entrance to the body by the mouth, it multiplies locally in the digestive tract, producing toxins which on absorption into the general circulation cause the various symptoms characteristic of the disease. It is noteworthy also that monkeys kept in a jail where beri-beri was prevalent suffered from a condition resembling the disease in man.

A NEW pattern of electric lamp is being put on the market by the Linolite Company. The filaments, instead of being in ordinary bulbs, are enclosed in short straight tubes about nine inches long; the filament is given a small curl in the middle to allow for expansion. These tubes are mounted end to end in a metallic casing, which serves as a reflector, and also carries the leads and the sockets into which the lamps fit. There is thus produced a single line of light, which is very suitable for certain forms of illumination, such as shop-window lighting, lighting by reflection from the ceiling, decorative illumination, and the like. The lamps are made for all ordinary voltages, and of the same candle-power and efficiencies as ordinary lamps; they are run in parallel for voltages up to 130, but for voltages above 200 the lamps are run in pairs, the two lamps of each pair being in series. The system has been tried on several occasions recently with very satisfactory results.

AT a recent meeting of the Academy of Sciences of Vienna, Prof. Molisch, of Prague, communicated a paper upon phosphorescent bacteria. He has been able to photograph the colonies of a phosphorescent micrococcus by means of its own light. By inoculating large glass flasks of 1–2 litres capacity containing a suitable culture medium with the organisms, a "bacterial lamp" is obtained with which it is quite possible for an observer at a distance of one to two metres to read a thermometer or to see the time of a watch. On a dark night the "bacterial lamp" is visible at a distance of more than sixty paces. It is suggested that such cultures of phosphorescent bacteria

might be employed in powder magazines, or for attracting fish, as the flask might be sealed up and lowered into the water. Under suitable conditions the phosphorescent properties of the cultures last for two to three weeks. It is to be noted that Mr. J. E. Barnard, of the Jenner Institute, some time ago similarly photographed cultures of phosphorescent bacteria, and that at a soirée of the Royal Society two years ago, Prof. Macfadyen and Mr. Barnard exhibited a fine series of cultures of phosphorescent micro-organisms.

THE new issue of the "Psychological Index, a Bibliography of the Literature of Psychology and Cognate Subjects for 1902," published in connection with the *Psychological Review*, has been compiled by Prof. H. C. Warren, of Princeton University, with the cooperation of M. J. Philippe and Dr. W. H. R. Rivers. It includes the titles of original publications in all languages, together with translations and new editions in English, French, and German.

THE third separate issue of the *Annuaire météorologique* is that for 1903, published by the Royal Observatory of Belgium under the supervision of M. A. Lancaster, the director of the Belgian meteorological service. Previous to 1900 there was a single annual publication devoted to astronomy and meteorology. M. Lancaster contributes to the present volume an elaborate article running to 130 pages on the force of the wind in Belgium; it contains an array of useful statistics and several interesting curves.

THE Geologists' Association has arranged an excursion to North Staffordshire for the Whitsuntide holidays. Stoke is to be made the centre from which geological excursions will take place. The members from London will leave Euston on Friday evening, May 29, and return on the following Wednesday evening. Notice should be sent to Mr. E. P. Ridley, Burwood, Ipswich, the excursion secretary, before May 15 by all who intend joining the excursion. An interesting programme of geological work has been arranged, and the daily visits should be enjoyable and instructive.

THE April number of the *Essex Naturalist*, the journal of the Essex Field Club, contains several sensible proposals for a photographic and pictorial survey of Essex, by Mr. A. E. Briscoe; an article on work in the field amongst the fungi, with additions to the flora of Epping Forest made at the fungus foray, 1902, by Dr. M. C. Cooke; and a paper by Messrs. A. S. Kennard and B. B. Woodward on the non-marine Mollusca of the River Lea alluvium at Walthamstow. The journal contains much other interesting material and a number of good illustrations.

MR. JOHN MURRAY has published a third edition of Mr. W. Robinson's "Alpine Flowers for Gardens. Rock, Wall, Marsh Plants, and Mountain Shrubs," which appeared first in 1870. The book has been revised, and should interest all lovers of horticulture in those plants which grow naturally on all high mountain-chains. Since the author states, in the prefatory note to this edition, that "there is not a garden, even in the suburbs of our great cities, in which the flowers of alpine lands might not be enjoyed," the addition of these mountain species to the garden plants usually cultivated in this country should greatly add to the interest of the amateur gardener's work.

THE additions to the Zoological Society's Gardens during the past week include a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, presented by Miss Ruby Ray; a Lesser Black-backed Gull (*Larus fuscus*) from Port Said, presented by Dixon Bey; a Capybara (*Hydrochoerus capybara*), a Brazilian Cariama (*Cariama cristata*), a Ypecaha Rail (*Aramides ypecaha*) from South America, presented by Colonel Sir T. H. Holdich, C.B.; a Yellow Baboon (*Papio cynocephalus*) from Africa, two Maholi Galagos (*Galago maholi*), a Leopard Tortoise (*Testudo pardalis*) from South Africa, an Indian Rat Snake (*Zamenis mucosus*), two Indian River Snakes (*Tropidonotus piscator*) from India, an Alligator Terrapin (*Chelydra serpentina*), two Alaska Geese (*Bernicla minima*) from North America, two Ross's Snow Geese (*Chen rossi*) from Antarctic America, three Lesueur's Water Lizards (*Physignathus lesueuri*), a Cunningham's Skink (*Egernia cunninghami*), a Gould's Monitor (*Varanus gouldi*), two Limbless Lizards (*Pygopus lepidopus*) from Australia, a Slender Loris (*Loris gracilis*) from Ceylon, two Large Greaved Tortoises (*Podocnemis expansa*) from the Amazons, three Starred Lizards (*Agama stellio*), a Spiny-tailed Uromastix (*Uromastix acanthinurus*) from North Africa, a Mailed Uromastix (*Uromastix loricatus*) from Persia, deposited.

OUR ASTRONOMICAL COLUMN.

COMET 1903 *b*.—From observations made at Windsor, N.S.W., on April 26, 29, and May 1, and communicated by telegraph to the Kiel Centralstelle, Herren M. Ebell and H. Kreutz have calculated the following elements and ephemeris for the comet discovered by Mr. Grigg on April 17:—

Elements.

T=1903 *March* 25·5486 *Berlin M.T.*

$$\left.\begin{aligned} \omega &= 186^\circ\ 40'{\cdot}7 \\ \Omega &= 213\ \ 14{\cdot}5 \\ i &= 66\ \ 29{\cdot}6 \end{aligned}\right\} 1903{\cdot}0.$$

$$\log q = 9{\cdot}71054.$$

Ephemeris for 12h. M.T. Berlin.

1903.	α h. m. s.	δ ° ′	log Δ	Brightness.
May 13	5 36 33	−22 2·8	0·1668	0·51
17	5 57 59	−22 53·9	0·1779	0·43
21	6 18 40	−23 34·9	0·1905	0·37
25	6 38 34	−24 7·2	0·2042	0·31
29	6 57 34	−24 32·2	0·2190	0·27
June 2	7 15 40	−24 51·2	0·2345	0·23

The brightness at time of discovery is taken as unity (*Kiel Circular*, No. 59).

A REMARKABLE ALGOL VARIABLE.—Prof. E. C. Pickering, writing to the *Astronomische Nachrichten*, No. 3866, states that the new Algol variable, 4.1903 Draconis, discovered by Madame Ceraski, is of unusual interest on account of its short period and great range of variability.

An examination of the plates obtained with the Draper telescopes shows that the period is 1d. 8h. 34·7m., and the range of variability 2·4 magnitudes. About half an hour before minimum the brightness decreases at the rate of between 2 and 3 magnitudes per hour, a rate probably greater than any other hitherto discovered. A minimum was predicted and observed at Harvard on March 19 at 16h. 24m. G.M.T.

NEW VALUE FOR THE SOLAR PARALLAX.—In view of the probable publication, in the near future, of the results obtained from observations of Eros, Herr B. Weinberg, of the University of Odessa, has collected about 130 of the more trustworthy values for the solar parallax as obtained by different observers, using various methods, since 1825, and has discussed them in a paper communicated to No. 3866 of the *Astronomische Nachrichten*. From the discussion he has obtained

$$8''{\cdot}8004 \pm 0''{\cdot}00243$$

as his final value for this constant.

INSTRUCTIONS TO OBSERVERS OF THE SUN.—In the April issue of the *Bulletin de la Société astronomique de France* an abstract is given of the first chapter of "Instructions pour l'Observation du Soleil," which will be issued to anyone desirous of systematically recording solar phenomena by the "commission solaire." The instructions give detailed and valuable suggestions on the observation and recording of the positions, size, nature and general details of sun-spots and faculæ, and also suggest the atmospheric conditions which should be recorded concurrently.

The object of the commission is to induce a large number of amateur astronomers, possessing instruments not exceeding 10 cm. in aperture, to participate in the collection of a large quantity of material for the discussion of the eleven-year period of solar variations.

STONYHURST COLLEGE OBSERVATORY REPORT FOR 1902.—This report contains a large amount of useful and detailed information and data as to the observations of meteorological and magnetical phenomena made at the Stonyhurst and St. Ignatius (Malta) Colleges during 1902, together with a report and some notes by Father Sidgreaves.

The sun was observed, at Stonyhurst, on 217 days, and on 110 days drawings of the solar surface were made. The spotted area of the sun observed during 1902 shows a return of solar activity, the figures (unity representing one-five-thousandth of the visible disc) for 1900, 1901, and 1902 being 0·55, 0·29, and 0·33 respectively.

Owing to unfavourable meteorological conditions the stellar spectrographic work was not very fruitful during 1902, but 44 good spectrographs of β Lyræ were obtained, and, as soon as circumstances permit, the results of an investigation of the spectrum of this star will be published.

OPENING OF THE JOHNSTON LABORATORIES FOR MEDICAL RESEARCH IN THE UNIVERSITY COLLEGE, LIVERPOOL.

A WORKING alliance between the forces of science and commerce is a condition of things that has of late been the prayer of many well-wishers to both. It is a happy union which, as we are often told with perfect truth, obtains less in this country than in many others. But in notable degree an exception must be made among our own communities in the case of Liverpool. The opening ceremony performed in Liverpool on Saturday last for the inauguration of the William Johnston Laboratories of the University College exemplified in a remarkable and memorable manner the strength of what is already in fact, and will in a few weeks also be in name, a university of municipal type.

Mr. William Johnston, shipowner, of Liverpool, last year munificently endowed a chair for biochemistry at the College, and also three fellowships for research in physiology, pathology and gynæcology. He has enhanced his splendid and far-sighted gift by now providing a large and well-equipped building for the laboratory purposes, not only of biochemistry, but of tropical medicine, experimental medicine, and comparative pathology. The large block housing these four subjects is built so as to adjoin, and have free internal communication with, the laboratories of physiology and pathology erected five years ago by the Rev. Thompson-Yates. These Johnston Laboratories form a building 90 feet long by from 35 feet to 50 feet wide. They constitute four floors in the entire block, each floor devoted to one separate department of research. It is noteworthy that in this building we find a university building in which there is not a single class-room or lecture-room in the ordinary sense of those words. From basement to roof it is devoted absolutely and exclusively to purposes of research. Tropical medicine is housed in the ground-floor, and is under the direction of Prof. Ronald Ross, F.R.S. The first floor is allotted to experimental medicine, under Dr. Albert Grünbaum, F.R.C.P., and a large proportion of its rooms are already occupied by cancer research. The second floor is entirely given to Prof. Moore's department of biochemistry, and its installation is nearly complete, two workers availing themselves of its equipment and facilities already. The basement, which is, in fact, only half-sunken and extremely well lighted, is entirely given to comparative pathology, under the direction of Dr. Annett.

The character of the arrangement of the fixtures and fittings of the laboratories deserves some notice. The leading idea has been to break up the internal space of the large area enclosed on each floor with the external walls as little as possible by permanent walls. The main floor is therefore cut up into compartments by wooden screens that do not reach the ceiling. These screens serve in many cases to carry, as walls, both shelves and cupboards, but they allow the twelve large windows to distribute light over every nook and corner of the whole. By this arrangement the laboratory is practically divided into bays, in which investigators can work separately, and surrounded on all sides by their working benches or shelves, and yet not obstructing the light of work going on elsewhere. A novel feature is that the floor of the rooms and the tops of the benches are made of polished *lito-silo*, a material which has resiliency, smoothness, and non-absorbent qualities, enabling it to be easily cleaned and disinfected. On all the floors there is a complete supply of water, gas, electric light, electric power, and steam. A lift, as well as a staircase, connects the floors together. The building is warmed by hot water and ventilated by the upper parts of the windows and by extraction shafts arranged down the centre of the rooms.

In the department of experimental medicine, some of the beautiful and costly apparatus provided has been furnished by the fund of 10,000*l.* recently given by Mr. Sutton Timmis for the prosecution of investigation into cancer. Dr. Albert Grünbaum, as the director of the cancer research, has already commenced experimental inquiries in this field on this floor of the laboratories. One of the rooms on the same floor is very fully equipped with electrical therapeutic apparatus of the most modern design.

The whole building forms a set of laboratories giving probably unsurpassed accommodation to the studies which it was raised to house. Certainly we have in the United Kingdom no other so fine laboratories of biochemistry or of tropical medicine. Their erection marks an era in the history of these studies in this country. That these subjects and other kindred direct extensions of physiology and pathology should now demand and obtain spacious accommodation is but one of the many indications that the trend of medical study, and therefore of medical education, has really entered upon a new route. The narrow and facile, but unfruitful and mentally circumscript ways of mere human anatomy are being exchanged for studies of more scientific character, and physical, chemical, zoological, or physiological in method and basis. This will demand, of course, better education in those entering the profession of medicine. It further inevitably connotes a closer association than at present between the art of medicine and pure science. Just as inevitably does it also presage an era probably even more fertile in achievements of biological study than that which we already couple with the names of Darwin and Pasteur.

The formal opening of the new laboratory was presided over by the Right Hon. Walter Long, President of the Local Government Board. A distinguished company attended. In addition to the staff and students of the University College, Mr. William Johnston, the donor, the Lord Mayor of the city, Mr. E. K. Muspratt, Sir John Brunner, Sir Alfred Jones, and many other well-known citizens were present. A large number of visitors, not only from various parts of the United Kingdom, but also from the Continent and America, had gathered to take part in the ceremony. Among these were Sir Michael Foster, Profs. Clifford Allbutt, Armstrong, Halliburton, Schäfer, Waller, Gotch, Stirling, Botazzi, Hausemann, Weigert, Nocard, Grützner, Blanchard, Uhlworm, Eulenberg, Perroncito, Delépine, Woodhead, Ravanel, Steegmann, Lorrain Smith, Macdonald, W. H. Thompson, Trevelyan, Drs. Rose Bradford, Monckton Copeman, Dawson Williams, Seaton, Bulstrode, and many others. In the evening Mr. William Johnston entertained a distinguished company to dinner at the Adelphi Hotel. The President of the Local Government Board, in the course of a vigorous speech on the necessity of progress being maintained in the advance of natural science by research in this country, declared that

science was the best friend any worker could call to his aid, whatsoever might be his particular part and calling in labour. Sir Alfred Jones submitted the toast of "Commerce and Scientific Research," replied to by Sir Michael Foster and Prof. Armstrong. To the toast of "Our Foreign Guests," Prof. Ravanel (Philadelphia), Prof. Nocard (Paris), Prof. Weigert (Frankfort), and Prof. Perroncito (Turin) replied.

THE IRON AND STEEL INSTITUTE.

THE annual meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers on May 7 and 8, and was very largely attended.

The report of the council, read by Mr. Bennett H. Brough, the secretary, showed that in 1902 the Institute had made very satisfactory progress. The membership amounted to 1692, and it was announced that the Institute had subscribed 1000*l.*, payable in five yearly instalments, to the funds of the National Physical Laboratory.

After the usual routine business, the retiring president, Mr. William Whitwell, inducted into the chair the president-elect, Mr. Andrew Carnegie. The first duty of the new president was to present the Bessemer gold medal to Sir James Kitson, which he did in felicitous terms. He then handed the Andrew Carnegie gold medal to Mr. A. Campion for his research on the heat treatment of steel, and a special silver medal to Dr. O. Boudouard, of Paris, for his research on the determination of the points of allotropic change of iron and its alloy. The research submitted by Mr. P. Longmuir, of Sheffield, on the influence of varying casting temperature on the properties of alloys was commended, and a further grant of 50*l.* was made to him to complete the work. Mr. Campion also received a further grant of a like amount to enable him to carry his researches further.

For the scholarships for the current year a large number of applications was received, and after very careful investigation of the claims, the council decided to award four scholarships of 100*l.*, each tenable for one year, to C. O. Bannister (London), to P. Breuil (Paris), to K. A. Gunnar Dillner in conjunction with A. F. Enström (Stockholm), and to J. C. Gardner (Middlesbrough), respectively.

Mr. Carnegie then delivered his inaugural address. It differed widely from all that have preceded it in that it dealt not with metallurgical technology, but with a consideration of the best and most economical methods of obtaining harmonious working between the mechanical and business departments of a concern, and of securing hearty cooperation between the employers and the employed. The address was much appreciated, and the thanks of the Institute were eloquently expressed by Sir Bernhard Samuelson and Sir David Dale.

The first paper read was by Mr. B. Talbot, of Leeds, who described the development of the continuous open-hearth process. Since this new departure in metallurgy was first described in 1900, considerable progress has been made, and a furnace of 200 tons has been in successful operation for some months at Pittsburg. Other furnaces of nearly the same capacity are being erected in Great Britain, in France, and in the United States. In the lengthy discussion that followed, Mr. E. H. Martin, of Pittsburg, adversely criticised the paper, whilst Mr. P. C. Gilchrist, Mr. E. Riley, Mr. Saniter, Mr. F. W. Paul, Mr. G. Ainsworth, Mr. Harbord, and Mr. T. H. Colley spoke in favourable terms of the process.

The meeting then adjourned until May 8, when Mr. Camille Mercader gave an account of the development in the manufacture of railway axles on a large scale accomplished at the works of the Carnegie Steel Company at Pittsburg. With the aid of numerous illustrations, he described a method of producing, by pressing, hollow axles having varying diameters. An animated discussion followed, in which Mr. R. M. Daelen and Prof. Bauerman expressed the opinion that the invention had been anticipated by Ehrhard, of Düsseldorf. Sir James Kitson, Mr. E. Windsor Richards, Mr. S. Lloyd, and Mr. Vaughan Hughes also took part in the discussion.

Prof. J. O. Arnold and Mr. G. B. Waterhouse, of Sheffield, then read an important paper on the influence of sulphur and manganese on steel. The steels examined were those experimented upon by Mr. Brinell. The results of the authors' investigations show that sulphide of iron is deadly in its effect upon steel, whilst sulphide of manganese is comparatively harmless; that the above facts are due to the fusibility, the high contraction coefficient, and the tendency of sulphide of iron to form cell walls or enveloping membranes surrounding cells of ferrite, whilst sulphide of manganese is much less fusible, segregates whilst the iron is at a high temperature, and so collects into rough globules, and very seldom into meshes; that manganese retards the segregation of iron and hardenite, and that what is called pearlite in a normally cooled manganese steel is really a mixture of granular pearlite and unsegregated ferrite; and that the complete segregation of the ferrite in a manganiferous steel can be brought about by very slow cooling, but that such annealing injures the mechanical properties of the steel by lowering the maximum stress and the reduction of area per cent. registered by the unannealed steel. An interesting discussion followed, in which Mr. Stead, Mr. F. W. Harbord, Mr. Vaughan Hughes, and Mr. Sidney Houghton took part.

The next paper read was by Mr. A. Keller, of Paris, who described the application of the electric furnace in metallurgy. This furnace, which is apt to be regarded merely as a laboratory appliance, will, the author thinks, find a place in the iron industry on a large scale. He shows that, although the manufacture of alloys which are little used can scarcely entitle it to rank as a metallurgical appliance, the production of ferrosilicon, which is one of the bases of modern metallurgy, and of iron, steel, copper, and nickel, will permit it to be regarded in this light. The success is the result of carefully controlled operations on a large scale at Livet, in the department of Isère. In the discussion, Mr. A. H. Allen, Prof. Arnold, Mr. B. H. Thwaite, Mr. A. Greiner, Mr. Stead, and Mr. Kilburn Scott bore testimony to the value of the invention.

Mr. C. von Schwarz, of Liége, described the best methods for making Portland cement from blast furnace slag, and showed that there is a wide field open to English blast furnace works for carrying on a profitable industry by the utilisation of their principal by-product. In the discussion Mr. Hutchinson described at considerable length the results obtained at Middlesbrough, and Mr. Stead spoke in optimistic terms of the future development of the manufacture.

Mr. Axel Sahlin next described an ingenious blast furnace top designed not to admit air or to permit gas to escape. Although the blast furnace top has been greatly modified and improved of late years in order to enable the furnace gases to be utilised, it still possesses certain defects which occasionally lead to explosions and other hindrances to efficient working. These drawbacks have been remedied in the blast furnace top described. The construction of this furnace top and its adjuncts ensures immunity from explosions, as no air can enter the furnace at the top, whilst it also provides against gas leaks and accumulations of dust. The success of the new top is demonstrated by its adoption at the Iroquois Iron Works, near Chicago, where the first one was started in 1901, and where fourteen are now working.

Mr. B. H. Thwaite then read a paper on the detrimental effect of flue dust upon the thermal efficiency of hot-blast stoves.

Colonel Cubillo, of Trubia, Spain, submitted an elaborate paper on the open-hearth process, in which he gave calculations of the heat balance of the furnace. The experiments on which the paper was based were carried out in a four-ton Siemens furnace of the new form.

Mr. J. E. Stead submitted a note on the alleged cementation of iron by silicon announced by Moissan and Lebeau. Mr. Stead's experiments show that at temperatures between 1100° and 1200° C. solid iron and free silicon do not combine, and that cementation by silicon is impossible when the iron and steel operated upon are in solid masses.

Prof. Thomas Turner, of Birmingham, submitted an analysis of a specimen of Sussex iron, some 200 years old. The results were as follows:—graphitic carbon, 2·89; combined carbon, 0·32; silicon, 0·62; sulphur, 0·08; phos-

phorus, 0·56; manganese, 0·77; and iron (by difference), 94·76.

The memoirs submitted by the Carnegie research scholars were taken as read, and are open to discussion by correspondence. The paper by Mr. A. Campion, for which the gold medal was awarded, covers seventy-five pages, and is illustrated by fifteen plates. It deals with the heat treatment of steel under conditions of steelworks' practice. The paper by Dr. O. Boudouard, of Paris, for which a special silver medal was awarded, covers eighty pages, and deals with the determination of the points of allotropic change of iron and its alloys by the measurement of the variations in the electric resistance. Results are given for carbon steels, chrome steels, tungsten steels, manganese steels, and nickel steels. The remaining memoirs presented by the Carnegie research scholars deal with the influence of varying casting temperature on the properties of alloys, by Mr. P. Longmuir, of Sheffield, and with the manufacture of tool steel, by Mr. E. Schott, of Berlin.

The proceedings concluded with the usual votes of thanks to the Institution of Civil Engineers, proposed by the president and seconded by Prof. Gowland, and to the president for his conduct in the chair, proposed by Prof. Syed Ali Bilgrami and seconded by Mr. F. Samuelson.

In the evening Mr. Carnegie presided at the annual dinner, which was attended by about six hundred members. The Prime Minister congratulated the Institute on its international and scientific character, and speeches were made by the Duke of Devonshire, Sir H. Campbell-Bannerman, Mr. John Morley, Viscount Ridley, Sir Henry Fowler, Sir James Kitson, and Sir Samuel Chisholm.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 248th meeting of the Junior Scientific Club was held on Friday, May 8. Mr. R. T. Günther read a paper on "Changes of Land Level," in which he gave an account of researches he had carried out on this subject in the neighbourhood of Naples. The paper was illustrated by slides showing photographs of the coast in this district. Mr. N. V. Sidgwick, Lincoln, read a paper on "The Emission of Heat by Radium Salts."

CAMBRIDGE.—The council of the Senate propose that the Hartley University College, Southampton, should be adopted as an institution affiliated to the University of Cambridge.

The syndicate on the Mathematical Pass Examinations have issued an important report (*University Reporter*, May 12, 1903), in which they recommend a number of far-reaching changes in respect to the geometry, arithmetic, and algebra required in the previous examination. They "are of opinion that it is no longer desirable to insist on the maintenance of Euclid's Elements as a text-book."

The Board of Agricultural Studies report that during the past year 169 students have received instruction in agricultural science in connection with the department. The income of the department, about 3700*l.*, is practically balanced by the expenditure. The need of a permanent building to accommodate the various branches of the work is becoming apparent, and the Board are considering how the need can be supplied.

Dr. Ruhemann, university lecturer in organic chemistry, has been appointed the university delegate to the Congress of Applied Chemistry to be held next month in Berlin.

A bust of the late Dr. John Hopkinson was unveiled at the engineering laboratory on Monday. The vice-chancellor presided, and the speakers included Sir Joseph Lawrence, M.P., Lord Kelvin, Prof. Ewing, and Principal Hopkinson.

DR. CHARLES CHILTON has been offered and has accepted the professorship of biology at Canterbury College, Christchurch, New Zealand, in succession to Prof. Dendy.

THE *Pioneer Mail* states that the site assigned to British India by the Mysore Government for the Indian University of Research to be created in consequence of Mr. J. N. Tata's munificent offer of an endowment measures about 370 acres, is situated in the north-west of Bangalore Cantonment, about four miles beyond the municipal boundary. Besides this gift the Mysore Government have offered five lakhs for initial expenses, and they hold out hopes of further assistance. Prof. Masson and Colonel Clibborn calculate the annual expenditure at 10,000*l.* sterling.

BOOTHAM SCHOOL, at York, was one of the few schools which received medals at the Nature-Study Exhibition last year for their exhibits showing the extent and nature of the work in nature-study done by the pupils. The sixty-ninth annual report of the Natural History Society of this school serves to explain the success then achieved. The study of natural objects is continued throughout the year, and is carefully arranged by the science masters so as to avoid waste of time and effort. A boy with a love for any branch of natural history receives every encouragement, and there can be little doubt of the good effect this sympathetic treatment has on the education imparted.

THE fiftieth report of the Charity Commissioners for England and Wales shows that in the three years ending December 31, 1901, the total amount of charitable bequests in England and Wales reached 6,542,110*l.*, of which 279,890*l.* was intended for education. It has often been pointed out in these columns what large sums are given to higher education in the United States. During the three years dealt with by the Charity Commissioners in their report, benefactions for higher education alone to the extent of 10,392,000*l.* were reported in the United States. That is to say, for every pound sterling given during 1899–1901 for education in all its grades in England and Wales, more than thirty-seven pounds were given by American benefactors for university education alone. The sums devoted by private persons to higher education in the United States were nearly twice as great during these three years as those for every form of charity in England and Wales.

NUMEROUS changes in the regulations for examinations at the University of Oxford have recently been announced. Among the alterations are those in mathematics for the first public examination (pass), in connection with which it is stated that any method of proof will be accepted which shows clearness and accuracy in geometrical reasoning, and that in the case of propositions 1–7, 9, 10 of Book ii., algebraical proofs may be used. The Board of the Faculty of Natural Science has also made similar changes in the mathematical requirements of the Final Pass School, Group C. (1). These changes come into force at the examinations of Michaelmas term, 1904. There are additions to the schedule of mechanics and physics for the preliminary examination of the Honour School of Natural Science, which come into force on and after Trinity term, 1905. The practical examinations, especially in physics, are to be more extensive than hitherto.

A COPY of the report and handbook for the session 1902 of the Technical Instruction Committee of the Essex County Council has been received. It contains detailed information of every department of the work of the committee, and provides another example of the thorough manner in which the county councils have performed the educational duties entrusted to them by the Technical Instruction Acts, now repealed. In connection with the agricultural instruction in Essex, field meetings were held at seven centres. The objects of some of the meetings were to demonstrate the destruction of charlock in field crops by spraying with solutions of copper sulphate and nitrate of soda; the improvement of derelict grass land by manures; no verbal description could adequately convey an idea of the improvement effected by basic slag, which was one of the manures used, on either of these fields, and the farmers attending were strongly impressed by the almost miraculous effect of this manure both on the quality and quantity of the herbage.

THE annual exhibition of the work of pupils in the day, evening continuation, truant, blind, deaf, and special instruction schools of the London School Board was opened last Saturday by Lord Reay at the Examination Hall, Thames Embankment. The exhibits were very numerous and thoroughly representative of the work of children of

all ages, from the lowest classes of infant schools to the evening classes for youths. Though considerations of space only permit particular reference to the section including the science exhibits from the schools of the Board, it may be said that the work shown from the manual training schools, the classes in domestic subjects, the institutions concerned with the physically and mentally defective, and from the classes in art subjects was highly creditable, and served admirably to show the extent and excellence of the work being done in the public elementary schools of the metropolis. The collection of pieces of apparatus to assist the teaching of science was this year much smaller than on previous occasions, the reason being that the offer of prizes for the most successful work was this year discontinued. It was satisfactory to notice that the plan recommended more than once in these columns was on this occasion carried out for the first time, and added much to the convenience of the visitor—we refer to the separation of the work of teachers and that of pupils. Judging from the exhibits, more attention appears to have been given during the past year to work with squared paper and to nature-study subjects, and there were some excellent relief maps made by boys of thirteen which would have been a credit to much older students. Altogether there is good reason to believe that the science work being done in the schools of the London Board, under the direction of Dr. Stewart and Messrs. Hubble and Todd, will lead to the development of habits of careful reasoning and alert observation.

SCIENTIFIC SERIAL.

American Journal of Science, April.—On the gaseous composition of the H and K lines of the spectrum, together with a discussion of reversed gaseous lines, by John Trowbridge. The continuous spectra observed in Geissler tubes when submitted to powerful disruptive sparks are not due to incandescence of the glass walls. The lines obtained coinciding closely with calcium lines, wave-lengths 3968 and 3933 are not due to calcium, but are true gaseous lines. The conclusion is drawn that the method of sifting out air lines from metallic spectra by observing the lines which are apparently common to these spectra and setting down such lines as air lines is a fallacious method.—The Boys radiomicrometer, by C. C. Hutchins. The simplicity and sensitiveness of this instrument indicate its employment in several lines of work, but the difficulty of preparing the small circuit which forms its fundamental part is very great. Details are given of the methods suggested by the author of overcoming these difficulties.—Meteoric iron from N'Goureyma, near Djenne, Province of Macina, Soudan, by E. Cohen. This meteorite belongs to the comparatively rare group of coarsely granular irons, and presents peculiarities of structure which appear to be unique. More than 97 per cent. of it consists of nickeliferous iron, the remaining constituents being schreibserite, troilite, daubreelite, lawrencite, and chromite.—Notes on the collection of Triassic fishes at Yale, by G. F. Eaton.—The mechanics of igneous intrusion, by R. A. Daly. A comparison of the hypothesis of overhead stoping in the formation of magma chambers with the laccolithic theory of crustal displacement, and with the theory of marginal assimilation of invaded formations.—*Brachiosaurus altithorax*, the largest known Dinosaur, by E. S. Riggs.—Some new structural characters of Palæozoic cockroaches, by E. H. Sellards.—The Bath furnace meteorite, by H. A. Ward. This meteorite fell on November 15, 1902, the date on which the orbit of the Leonids cuts that of the earth. The stone consists essentially of olivene and pyroxene, with troilite and metallic sprinklings. There is also present in small quantities a completely colourless, almost isotropic mineral, which is probably maskelynite.—The use of a rotating kathode in the electrolytic determination of the metals, by F. A. Gooch and H. E. Medway. An ordinary platinum crucible, rotated by a small electric motor at a speed of 600 to 800 revolutions per minute, is used as the kathode. Details of experiments with copper, nickel and silver are given, from which it would appear that much higher current densities may be employed than with the usual apparatus without any appreciable loss of accuracy.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, April 22.—Prof. W. A. Tilden, F.R.S., president, in the chair.—The following papers were read:—The velocity and mechanism of the reaction between potassium ferricyanide and potassium iodide in neutral aqueous solution, by F. G. **Donnan** and R. **le Rossignol**. The velocity of this reaction can be investigated by titration of the iodine liberated; the simplest interpretation shows that it is quinquemolecular.—A microscopic method of comparing molecular weights, by G. **Barger**. Small quantities of the two solutions are introduced into a capillary tube, where they form bi-concave, discoid drops, care being taken to use the solutions alternately, so that each drop of one solution is enclosed between two drops of the other. The capillary tube is then sealed at both ends, and the length of each drop is measured microscopically from day to day until no change in volume is apparent. At this point the solutions are equimolecular.—Note on the spectrum of pilocarpine nitrate, by W. N. **Hartley**. The author states that the curve recently described by Dobbie as that of the ultra-violet absorption spectrum of pilocarpine nitrate is that of nitric acid slightly modified by the alkaloid present.—Isomeric change of dipropionanilide into propionyl-*p*-aminopropiophenone, by Dr. F. D. **Chattaway**. Under the influence of various catalytic reagents, *e.g.* zinc and hydrogen chlorides, dipropionanilide, like diacetanilide and dibenzanilide, undergoes transformation into propionyl-*p*-aminopropiophenone; the latter and some of its derivatives are described.—Note on the formation of di- and hexamethylammonio-cadmium chlorides, by W. R. **Lang**. Dry methylamine and cadmium chloride react at $-11°$ to form a white powder of the composition $CdCl_2,6CH_3.NH_2$. This, when heated to 100°, furnishes a stable substance of the composition $CdCl_2,2CH_3.NH_2$.

Royal Astronomical Society, May 8.—Prof. H. H. Turner, president, in the chair.—The president announced that the council had elected Lady Huggins and Miss Agnes M. Clerke honorary members of the Society.—The secretary read a paper by the Rev. S. J. **Johnson** on a possible cause of the moon's obscurity on April 11, in which the author suggested that the presence of volcanic dust in the earth's atmosphere was the cause of the darkness of the moon's disc during the recent partial eclipse.—Mr. **Lewis** gave an account of a series of measures of double stars made with the 28-inch refractor at the Royal Observatory, Greenwich, during 1902, and described the orbits of some stars of especial interest.—Mr. Bryan **Cookson** gave a short account of his work on the satellites of Jupiter during a recent stay of two years at the Royal Observatory, Cape of Good Hope.—The Astronomer Royal exhibited and explained a series of diagrams of sun-spots and magnetic disturbance observed at the Royal Observatory during the years 1874 to 1901.—Dr. **Rambaut** read a paper on occultations of stars observed at the Radcliffe Observatory, Oxford, during the lunar eclipse, as well as observations of the colour of the shadow, penumbra, &c.—The president suggested certain subjects for discussion, and a short discussion took place on Mr. Percival Lowell's recent proposal of a standard scale of "seeing."—Mr. A. R. Hinks read extracts from a letter from Mr. **Ritchey**, of the Yerkes Observatory, in which he described his methods of developing photographs of nebulæ, &c. Mr. Ritchey stated that with regard to such nebulæ as those of Andromeda or Orion he made his prints from a negative in which the central portions had been reduced. He considered that the star images are smaller on a negative that had been developed extremely slowly.

Anthropological Institute, April 28.—Mr. H. **Balfour**, the president, exhibited specimens of the tools used by the natives of North-West Australia in the manufacture of glass spearheads. The tools consist of a piece of a sheep's leg-bone and of a water-worn pebble of a purely natural shape. The pebble was used in the earlier stages of the spearhead's manufacture, while the bone was used in its final shaping. Mr. Balfour also exhibited a spearhead which had been made with these tools. A full account of the exhibit, illustrated with a plate, will be found in the May number of

Man.—Mr. E. N. **Fallaize** read a paper on the classification of the subject-matter of anthropology. After defining anthropology quite generally as the "science of man," and pointing out how vast was the scope of such a science which must include all that man *is* and all that man *does*, Mr. Fallaize suggested the following classification of the questions with which the science has to deal:—A. Man's place in Nature, including under this head the investigation of man's place in time and man's place in space, the first section (for which the term palæanthropography was suggested) dealing with the origin and descent of man, Tertiary man, the physical types of the Stone, Bronze, and Iron ages; the second with the distribution of mankind, and the classification of races by physical types—general ethnology. Under B. fall all questions dealing with physical structure—anthropography; while C. deals with the functioning of the organs—physiological anthropology—including such questions as heredity, atavism, racial fertility, and the like. Section D. deals with specifically human activities in the following order:—(*a*) gratification of the senses, including dancing and the æsthetic arts; (*b*) gratification of the intellect, the sciences, especially in the earlier stages of their development; (*c*) communication of ideas, language and writing; (*d*) social structure, the individual and the social organism; (*e*) man's intercourse with Nature: (α) material nature—technology; (β) immaterial nature—the study of religion and folklore.—Mr. J. **Gray** read a paper on the measurements of the Colonial Coronation contingent. The paper contained an analysis of the measurements of about one hundred men of the native troops encamped at the Alexandra Palace during the Coronation celebrations. Amongst the races measured were natives of Sierra Leone and the West Coast of Africa, Nigeria, Lagos, Old Calabar, Central Africa and Somaliland; also Fijians, Maoris, Chinese and Singhalese. The mean values of the head dimensions and stature were calculated for each group, and also possible deviations from the mean in other samples. The results were plotted out on a chart, and the conclusions arrived at were that broadly the same race stretches from Sierra Leone to Somaliland, but that towards North Africa the breadth of the head increases. The Asiatic and Polynesian races, such as the Chinese, Fijians, and Maoris, were infallibly distinguished from the African races by the greater breadth of their heads. The measurements of the African races showed remarkably good agreement with Mr. Randall MacIver's measurements of the Berbers, and Sir H. Johnston's measurements of the Central Africans.

Zoological Society, April 21.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—Mr. Henry **Scherren** read a short paper dealing with the literature of feather-tracts as found in the writings of Hunter and Linnæus. The author directed attention to a figure in the "Amœnitates" (1766) in which these tracts were shown, and suggested that a passage in "The Garden of Cyrus" proved that Sir Thomas Browne knew of them, and that they varied in extent and position in different birds.—Mr. Oldfield **Thomas** read a paper on some mammals collected by Captain H. N. Dunn in the Egyptian Soudan. Nineteen species were enumerated, of which five were described as new.—In a paper on the geographical distribution of the Mygalomorphæ, an order including the trapdoor spiders and the species formerly grouped together under the comprehensive title Mygale, Mr. R. I. **Pocock** pointed out that the known facts justified the mapping of the world into the following zoological regions:—(1) The Holarctic, including Europe north of the southern mountain chains, North Asia, and North America north of about the 45th parallel of latitude. (2) The Mediterranean, including South Europe, Africa north of the Sahara, and the desert regions of South-western Asia. (3) The Sonoran, including the United States of America south of about the 45th parallel of latitude and the plateau of Mexico. (4) The Ethiopian, including Africa south of the Sahara, South Arabia, and Madagascar. The last-mentioned island ranks merely as a subregion of the Ethiopian. (5) The Oriental, including India, Ceylon, Burma, Siam, and all the Indo- and Austro-Malayan Islands to Australia, "Wallace's line" being non-existent so far as spiders are concerned. (6) The Australian, including Australia and New Zealand, the latter being worthy of recognition as a subregion. (7) The Neotropical, including Central America, apart from the Mexican plateau, the West Indies and South America. These spiders, moreover, furnished very strong evidence in favour of a former union between Africa and South America, and of a connection between the Afro-Mascarene and Austro-Zelandian continents on the one hand, and Austro-Zelandia and the southern extremity of South America on the other.—Mr. **Woodland** read a paper on the phylogenetic cause of the transposition of the testes in mammals.—A communication from Mr. F. F. **Laidlaw** dealt with the marine Turbellaria collected during the "Skeat Expedition" to the Malay Peninsula. In it ten new species were described, three of which were referred to new genera.

MANCHESTER.

Literary and Philosophical Society, April 21.—Mr. Charles Bailey, president, in the chair.—Mr. Spencer **Bickham** read a paper on caoutchouc, in which he described the methods of collection and preparation employed in the different countries where this product is obtained, and remarked upon the geographical distribution of the trees from which caoutchouc is extracted.

PARIS.

Academy of Sciences, May 4.—M. Albert Gaudry in the chair.—Notice on Admiral Ernest de Faulque de Jonquières, by M. E. **Guyou**.—Waves of the second order with respect to their velocity in vitreous media, possessing viscosity, and affected by finite movements, by M. P. **Duhem**.—On some physical properties of trimethylcarbinol, by M. **de Forcrand**. Determinations of the melting and boiling points, specific heat in the solid and liquid states, heat of fusion and volatilisation are given.—On glycuronic acid in the blood, by MM. R. **Lépine** and **Boulud**.—On the ancient lines of the Pliocene and Quaternary beaches on the French coasts of the Mediterranean, by M. Ch. **Depéret**. A preliminary study of the changes of level of the Mediterranean from the Pliocene epoch up to the present time. Four distinct lines of beach can be made out; the early Pliocene at an elevation of 170 to 175 metres, the recent Pliocene at an elevation of 60 metres, early Quaternary at an altitude of 25 metres, and a later Quaternary at an altitude of 4 to 5 metres. The hypothesis of a simple series of negative movements lowering the level of the sea is insufficient to explain these facts.—Remarks by M. Edmond **Perrier** on the sixth volume of his "Traité de Zoologie."—Secular perturbations, by M. Jean **Mascart**.—The period of the sun-spots and the mean annual temperature variations of the earth, by M. Charles **Nordmann**. The work of Köppen has shown that it is only in tropical stations that any connection can be traced between the mean annual temperature and the sun-spot frequency. A study of the observations made at twelve tropical stations shows that the mean annual temperature undergoes a variation the period of which is sensibly equal to that of the sun-spots. The effect of the spots is to diminish the mean terrestrial temperature, that is to say, the curve which represents the temperature variations is parallel to the inverse curve of the sun-spot frequency.—On the twilights observed at Bordeaux during the winter of 1902–1903, by M. **Esclangon**. The hypothesis of finely suspended dust being the cause of the phenomenon would appear to be insufficient. It is more probably due to clouds.—On the Γ function and its analogues, by M. A. **Pellet**.—On the approximation of numbers by rational numbers, by M. Émile **Borel**.—On the relative motion of the work and the tool in cutting the section of a mechanism, by M. G. **Koenigs**.—A transmission dynamometer giving directly the work in kilogrammetres, by MM. **Gaiffe** and **Günther**. An electrical contrivance by means of which the work can be directly read off on an ammeter. The apparatus can be easily arranged to be self-recording.—The theory of electric and magnetic dichroïsm, by M. Georges **Meslin**.—The repulsion of the anode light by the kathode rays, by M. **Salles**.—On metallic diaphragms, by M. Andre **Trochet**. If a plate of platinum is interposed between the two electrodes of a copper voltameter, when the current has attained a certain density, copper is deposited on the platinum. The dependence of this deposit upon the current and the shape of the bipolar electrode is studied quantitatively.—On compounds of aluminium

chloride possessing the function of a ferment, by M. G. **Gustavson.** A study of the action of the intermediate compounds formed in the Friedel and Crafts reaction.—On the action of phosphorous acid on erythrite, by M. P. **Carré.** Phosphorous acid acts towards erythrite as a less energetic dehydrating agent than phosphoric acid. Prolonged action gives a neutral phosphite of erythran, and this is immediately decomposed by water, the acid ester being formed.—Contribution to the study of organic acids, by MM. Œchsner **de Coninck** and **Raynaud.** An examination of the relative stability of the lower members of the fatty acids towards hot concentrated sulphuric acid.—On the heat of formation of some barium compounds, by M. **Guntz.** Starting with metallic barium containing about 98·5 per cent. of the metal, the thermal changes associated with its solution in water and dilute hydrochloric acid have been determined, and the heat of oxidation of barium deduced.—On the chlorides of chlorocinnamylidene and bromocinnamylidene, by MM. Ernest **Charon** and Edgar **Dugoujon.** —The transformations of diphenylcarbonic esters and monosalicylic esters, by M. R. **Fosse.**—On a new diiodophenol, by M. P. **Brenans.** A description of the mode of preparation, properties, and chief derivatives of the diiodophenol (OH) : I : I,I : 3 : 4.—On some new bases derived from the pentoses, by M. E. **Roux.** The new bases, arabinamine and xylamine, are prepared by the reduction of the oximes of arabinose and xylose.—The action of alkalis on glycerol. The application of the reaction to the estimation of glycerol, by M. A. **Buisine.** On heating potash lime with glycerol three different reactions may take place according to the temperature. At 320° the products are potassium acetate, potassium carbonate, water and hydrogen, and a method suitable for the estimation of small quantities of glycerol can be based on the measurement of the hydrogen.—On the existence of arsenic in the egg of the fowl, by M. Gab. **Bertrand.** All parts of the egg were found to contain appreciable amounts of arsenic. These results confirm the existence and probable function of arsenic in all living cells. —The influence of the radium rays on fertilised eggs, and on the first stages of development, by M. Georges **Bohn.** —On the formation of melanic pigment in the tumours of the horse, by M. C. **Gessard.** The abnormal production of black pigment in the healthy or morbid tissues of man is rare, but is very common in the horse. The chromogenic substance is tyrosine, the oxidation of which by tyrosinase which is present gives the colouring matter.—The law of action of trypsin on gelatin, by MM. Victor **Henry** and Larguier **des Bancels.** The action was followed by the changes produced in the electrical conductivity.—On the increase in weight in white mice, by Mdlle. M. **Stephanowska.**—On a new secreting apparatus in the Coniferæ, by M. G. **Chauveaud.**—The development and anatomical structure of the seminal tegument in the Gentianaceæ, by M. Paul **Guerin.**—A respiratory hygrometer, by M. Pierre **Lesage.** A modified form of dew-point hygrometer. It has been found that the pressure of the water vapour in expired air does not correspond to the saturation pressure, and varies with state of the man.—The germination of the spores of truffles, the culture and characters of the mycelium, by M. Louis **Matruchot.**—On the echinitic fauna of the Gulf of Suez, by M. R. **Fourtau.**—On the closed basins of the Swiss Alps, by MM. Maurice **Lugeon,** Maurice **Ricklin,** and F. **Perriraz.**

DIARY OF SOCIETIES.

THURSDAY, MAY 14.

ROYAL SOCIETY, at 4.30.—The Combination of Hydrogen and Chlorine under the Influence of Light: P. V. Bevan.—On the Photo-Electric Discharge from Metallic Surfaces in Different Gases: Dr. W. Mansergh Varley.—The Elasmometer, a new Interferential Form of Elasticity Apparatus: A. E. Tutton, F.R.S.—Meteorological Observations by the Use of Kites off the West Coast of Scotland, 1902: Dr. W. N. Shaw, F.R.S., and W. H. Dines.—On the Radiation of Helium and Mercury in a Magnetic Field: Prof. A. Gray, F.R.S., and Dr. W. Stewart; with R. A. Houston and D. B. McQuistan.—A New Class of Organo-Tin Compounds containing Halogens: Prof. W. J. Pope, F.R.S., and S. J. Peachey.—The Xanthophyll Group of Yellow Colouring Matters: C. A. Schunck.

ROYAL INSTITUTION, at 5.—Proteid-Digestion in Plants: Prof. Sidney H. Vines, F.R.S

MATHEMATICAL SOCIETY, at 5.30.—Generational Relations Defining an Abstract Simple Group of Order 32736: W. H. Bussey.—Points in the Theory of Continuous Groups: Dr. H. F. Baker.—On Fermat's Numbers: Lieut.-Col. Cunningham and Messrs. Western and Cullen.

SOCIETY OF ARTS, at 4.30.—The Province of Assam: Sir James Charles Lyall, K.C.S.I.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Applications of Electricity in Engineering and Shipbuilding Works: A. D. Williamson.—Electric Driving in Machine Shops: A. B. Chatwood.

FRIDAY, MAY 15.

ROYAL INSTITUTION, at 9.—The Origin of Seed-Bearing Plants: D. H. Scott, F.R.S.

MONDAY, MAY 18.

SOCIETY OF ARTS, at 8.—Mechanical Road Carriages: W. Worby Beaumont.

TUESDAY, MAY 19.

ROYAL INSTITUTION, at 5.—The Astronomical Influence of the Tides: Prof. G. H. Darwin, F.R.S.

ROYAL STATISTICAL SOCIETY, at 5.—The Growth and Direction of our Foreign Trade in Coal during the Last Half Century: D. A. Thomas, M.P.

WEDNESDAY, MAY 20.

CHEMICAL SOCIETY, at 5.30.—Isomeric Partially Racemic Salts containing Quinquevalent Nitrogen. Part xi. Derivatives of *dl*-Methylhydrindamine and *dl-neo*-Methylhydrindamine. Isomeric Salts of the Type $NR_1R_2H_3$: G. Tattersall and F. S. Kipping.—The Conditions of Decomposition of Ammonium Nitrite: V. H. Veley.—Note on the Action of Methylamine on Chromic Chloride: W. R. Lang and E. H. Jolliffe.—The Action of Liquefied Ammonia on Chromium Chloride: W. R. Lang and C. M. Carson.—Cholesterol. A Preliminary Note: R. H. Pickard and J. Yates.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Exhibition of Pond Life.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—The Relation of the Rainfall to the Depth of Water in a Well: Charles P. Hooker.—The Frost of April, 1903: William Marriott.

THURSDAY, MAY 21.

ROYAL INSTITUTION, at 5.—Proteid-Digestion in Plants: Prof. S. H. Vines, F.R.S.

FRIDAY, MAY 22.

ROYAL INSTITUTION, at 9.—Dictionaries: Dr. J. A. H. Murray.

CONTENTS.

THURSDAY, MAY 21, 1903.

THE PRINCIPLES OF DISEASE.

The Prevention of Disease. Translated from the German. With introduction by H. H. Bulstrode, M.A., M.D. Pp. xviii+1063. (Westminster: A. Constable and Co., Ltd., 1902.) Price 31*s.* 6*d.* net.

IN all studies we are turning back to remoter and remoter causes, and to the investigation of origins; but, as we abstract and abstract, we are apt to get vaguer and vaguer, more and more are individual features merged in types, and in medicine we may find ourselves reduced at last to the emptiness of general counsels for a temperate and wholesome life. Nevertheless, the modern physician cannot be content with the knowledge that the patients under his care are victims of phthisis, of Bright's disease, of failing heart, of premature senile decay, and so forth, without a desire to learn the nature and direction of the processes by which such changes are initiated. As in but few instances he has discovered these small beginnings he is discontented; and it is well that he should be so. Our ancestors did not fail to see that diseases are moving things, so active that some demon or evil principle might be behind them; but this conception of activity, effective enough for instant purposes, contained no adequate notion of remote or latent causes. Some such notions may be traced in the ancient doctrines of the temperaments or diatheses, but were speculative and comparatively barren. Initial causes were, as we should expect, first observed and revealed in the infections, when a definite external pathogenic factor enters into a healthy or apparently healthy person; but even such events would seem to be very inconstant in their occurrence. Of two men exposed to such an attack, one would betray no sign of suffering, while the other would fall ill; an inconstancy indicating that the causation of an individual case of infection consists of far more than the intrusive element itself, which in some cases impinges upon a series of cooperating, in others of antagonistic causes. And if the patient succumbs, the outbreak of disorder is not immediate; a variable but specific interval elapses before its first manifestations. Now if from the recognised infections we turn to other diseases, we try to discover if some of these also arise from incidental agencies of a more occult kind, but having also their latent periods and gradual initiations. Others, again, may not be attributable to external elements, scarcely even as secondary and accelerating causes; but arise as later terms of processes implicit in the organism itself, perhaps even from the embryo.

Now the more definite and prevalent the outer causes, as in the more notable infectious diseases, the better is our position, if we can discover the laws of them, to take preventive and defensive measures on an extensive scale, and to entrust them to public physicians acting on behalf of individuals only as members of a community. On the other hand, the more a disease is the outcome of individual and peculiar proclivities, the less are such public and universal precautions available against it. Public health may be secured by universal rules and enterprises, but the health of individuals, so far as it involves a study of the constitution of each one of them, must be a matter of private practice; though diseases such as phthisis, which arise from a cooperation of general and personal factors, need for their prevention a combination of public and private means.

In respect of epidemic infections, which can be studied on public lines, and have more definite causes and periods, much has been done in the way of prevention since the time of those first medical officers of health, the fetishman or voodoo; but, as Dr. Bulstrode says in his able preface to the volume before us, similar investigation of remote and initial causes, and the preventions to be based upon them when detected, have made but little way as yet in constitutional diseases. Indeed, Dr. Bulstrode goes so far as to suggest, justly as we think, that one of the uses of this book on the prevention of disease in its broader and yet more intimate sense, will be to force upon the notice of physicians that, meritorious as it is to stem the tide of established maladies, this function would be less and less in demand if our insight into and means of detection of their incipient terms were more largely developed. It is the chief merit of the work before us that, perhaps for the first time, our conception of preventive medicine is carried in a formal and imposing way beyond the sphere of the infections; and the first comprehensive attempt is made to apply preventive principles to the initial phases of all diseases.

The dangers of such an enterprise are obvious; when we leave conspicuous and specific phases of change, and seek for the more abstract and universal springs of disordered health, we run the risk of losing not only colour and vivacity, but grip and precision also. As we empty our conceptions of individual characters, we may lapse into platitude. In the construction then of a pioneer work on these broad lines, and on these remoter and vaguer conditions of disease, especial care should be taken to avoid such triviality, and to convince the reader that in tracing rivers to their sources the explorers have not lost themselves in a multitude of shallow rills and in a confusion of forests and watersheds. In this somewhat uncomely, and, seeing that illustrations were not needed, expensive volume, we think that the dangers we have indicated have not been avoided altogether. In a cooperative work we expect to find writers of very wide differences of merit; some good, some middling, some really trivial: but the jealous regard for precision and touch with nature which, as we have seen, should be the note of such a work, and the antidote to its summary methods, has not always been enforced by the editors. The introductory article on the history of the prevention of disease among the Hindoos, Chinese, Israelites, &c., was scarcely worth doing on so small a scale, and is certainly slight enough: it contains some interesting points; but others are not thought out, many statements are loose, and not a few

positively erroneous. We find, for example, the amazing statement that the *speculum vaginae* was unknown until a hundred years ago; yet of medical historians who could forget, at least, the *locus classicus* in Paul of Egina concerning this instrument in its valve and screw form, and the instructions for its use? In the same article we have dubious quotations from such still more dubious authors as "Tralus" (*sic* in text and index; for Alexander of Tralles?) and "Calomella" (a version redolent of the shop!), slips which do not reinforce our confidence in the author's general accuracy. If the editors are to blame for some of these oversights, they are surely still more to blame for passing sentences either so ignorant or so unfair as this:—

"It has been shown, by Koch and others, that malaria is conveyed largely, if not entirely, through the instrumentality of certain mosquitoes."

"Koch and others" is good. "Surmise," again, is far too feeble a word to indicate the epoch-making theory and practice of Semmelweiss in puerperal fever. The next article, by one Martins of Rostock—so he is called in the contents, index, and in all cross references—is a far abler one. We are disposed to attribute it to Prof. Martius. That we ourselves, and we are glad to observe Dr. Bulstrode also, differ profoundly from him in some important respects is not, of course, to be pressed to his disadvantage.

It would be impossible for us, even within limits far wider than the present, to discuss each of the many articles in turn, or, indeed, within the limits of leisure and patience, to read them all critically. For the most part the bread is too deeply drowned in sack. In many chapters there is little but some character of attenuation to distinguish the contents from the therapeutical sections of current text-books; while there is much to remind us of the lip medicine of the student, with his common formulas, such as that "the patient is to be put upon a light and nutritious diet," &c. In turning to the index for fresh light upon the initial causes of particular maladies, we find too often nothing, as in the case of gall-stones, pernicious anæmia, acute rheumatism,[1] scurvy and certain other maladies in which new knowledge seems to promise to be of high preventive value; or we find such vapid paragraphs as are given to arterial diseases, senile decay, dilatation of the stomach, &c.; or, again, equivocal names, such as "anæmia" undistinguished from chlorosis and other particular kinds of impoverished blood. Thus too often general views are attained only by slurring over essential differences. We have sought in vain, moreover, for recent observations on the geographical distribution of cancer; and for the significant fact of the prevalence of primary cancerous growths upon the surfaces of the body.

We are sorry we cannot speak with more appreciation of this important book; but we feel, as Dr. Windscheid, of Leipzig—the able author of the chapter on the prevention of diseases of the nervous system—evidently does, that it is difficult to avoid falling, as some of his collaborators certainly have done, between the stool of specific detail and that of general gossip. However, that a work with such aims should appear at all is satisfactory; we could scarcely expect the first attempt to be one of full achievement. The translations, if slipshod at times, are, as the editors claim for them, readable English enough; but the editors have failed too frequently, whether in the text or by means of notes, to modify facts and opinions, as, for instance, in respect of the diet of the working classes, hours of labour, the management of schools and so forth, which, however true of German societies, are inapplicable to English conditions.

T. C. A.

[1] For the recent views of the causation of rheumatism we searched the index and found a reference to p. 112, but failed there to find any such discussion. There are many errors in the index.

ZOOLOGY FOR ARTISTS.

Anatomie artistique des Animaux. By Éd. Cuyer. Pp. xii+300; 143 figs. (Paris: J.-B. Baillière et fils, 1903.) Price 7.50 francs.

DOZENS of treatises on the anatomy of the human body have been written for the use of artists, but this is the first systematic attempt to place a knowledge of the structure of the more common mammals at their disposal. During the last ten years, M. Édouard Cuyer, who is a lecturer on anatomy at l'École nationale des Beaux-Arts, has been in the habit of adding to his ordinary lectures on the structure of the human body a number dealing with the anatomy of the mammals more commonly drawn by artists. The preparation of these lectures entailed much research, and hence this work, which is based on the lectures, not only treats comparative anatomy from a new point of view, but also contains a number of original observations. In this country M. Cuyer is best known as an illustrator of anatomical subjects; in this *rôle* he stands unrivalled, and the drawings which he has supplied for the work under review are the most accurate representations to be found in any work dealing with the anatomy of mammals.

No question has been more debated than the value of anatomy as an aid to art. Ruskin's dictum was that an artist should paint what he could see, not what he knew he ought to see; he even went further, and held that art was debased by a knowledge of anatomy. However that may be, one might have seen, a few years ago, Onslow Ford, Briton Rivière, and J. M. Swan, three of the most truthful and successful animal modellers and painters this generation has produced, dissecting and drawing, hour after hour, in the prosectorium in the Zoological Gardens at Regent's Park. M. Cuyer cites the great animal painter Barye as an example of an artist whose work has gained in force and precision by his accurate knowledge of anatomy. Anyone familiar with either the work of Barye or Swan will recognise that they are real zoologists who epitomise in their modellings and drawings the living and essential nature of the animals portrayed.

M. Cuyer presumes that the student is already familiar with the structure of the human body, which is made the basis for a comparative study of anatomy.

At first sight the human body may appear too highly specialised to serve as an efficient type for comparison, but in reality this is not so. The fact that the ordinary mammal presents a side view to the artist while the human body is usually studied from the front is merely one of detail. The chief points in which the human and ordinary mammalian bodies differ relate to the head and limbs, and the limbs of man are more primitive in structure, less specialised and evolved than those of the ordinary domestic animals. The evolution of the quadrupedal limbs forms an interesting study in high specialisation of one or more digits and retrogression in others, and it is from this standpoint that M. Cuyer deals with the anatomy of the extremities of the domestic animals. Through the limbs of the cat, dog, pig, ox and horse he traces the gradual retrogression of the clavicle, muscles of supination and pronation, ulna, and lateral digits, and shows how these modifications are due to the specialisation of the limbs as organs of pure support instead of mixed instruments for prehension as well as support. His discovery of a vestige of the *pronator radii teres* in the horse is of great interest; how many millions of years is it since the ancestor of the horse required to supinate or pronate its arm?

In the hands of the artist the whole perspective of anatomy becomes changed, and it would be for the benefit of our text-books if the pure zoologist sometimes looked at his work with the eye of an artist. M. Cuyer recognises the fact that an observation on the dead animal remains dead until it is transferred to the living, and the great merit of his work is that he lays a greater emphasis on the actions than on the attachments of muscles. External form, expression, and action are the points which an artist seeks to understand; hence the systems of the body dealt with here are the skeleton, muscles, proportion, and movements. Everyone must have noticed the marked difference in form between the haunches of an ox and of a horse, yet it is doubtful if any of our modern comparative anatomists could indicate the meaning of these structural differences.

Marey's work forms the basis of the chapters in which are described the various characteristic movements of the horse. In dealing with the proportions of the ideal horse M. Cuyer holds the common-sense opinion that there is no absolute standard such as that suggested by Bourgelat, who held that the length of the body from the shoulder to the rump should measure the same as the height at the withers. The observations of Colonel Duhousset on fifty Arabian horses are quoted; in ten of these the length and height were equal; in twenty-six the height was decidedly the greater measurement; in fourteen the length was the greater.

M. Cuyer, as is the habit with many French scientific writers, quotes no author outside the limits of his country. On p. 33, for instance, he refers to an observation by Marey, made in 1890, that there is no correlation between the power of flight and the development of air cells in birds. This matter was fully studied and accurately described in the well-known work of John Hunter a century before Marey was born.

HINDU CHEMISTRY.

A History of Hindu Chemistry from the Earliest Times to the Middle of the Sixteenth Century A.D., *with Sanskrit Texts, Variants, Translation and Illustrations.* By Prafulla Chandra Rāy, D.Sc., Professor of Chemistry, Presidency College, Calcutta. Vol. i. Pp. lxxix+176+41. (London and Oxford: Williams and Norgate, 1902.) Price 12*s.* 6*d.* net.

THE origin of Hindu chemistry is hidden in the obscurity of past ages. It is certain that the alchemists of western Europe owed much of their learning to the Arabs. M. Berthelot, in "Les Origines de l'Alchemie," has shown that the Arabs derived many of their ideas from the Greeks, but Dr. Rāy quotes other weighty opinions, and furnishes additional evidence in support of the view that the Arabs were even more indebted to the Hindus. In the eighth century the Caliphs of Bagdad ordered several of the medical works of India to be translated, and both then and later learned Arabs were sent to India to study science. Not content with pointing out these facts, Dr. Rāy reminds his readers that the Greeks themselves derived their knowledge of many things from the Hindus, who had, for example, solved the 47th proposition of the first book of Euclid, 200 years before the birth of Pythagoras. Relying on this and similar evidence, Dr. Rāy places the date of the works of Vāghbata at some time before the eighth century A.D., and the surgical and medical treatises of Susruta and Charaka many centuries earlier, in pre-Buddha times. The last-named book, however, "embodies the deliberations of an international congress of medical experts, held in the Himālayan regions," and the fourth veda, the Atharva-veda, appears so archaic by its side that it must be older by "probably a thousand years or more." In the Atharva-veda "plants and vegetable products in general are fully recognised as helpful agents in the treatment of diseases," and at that period (say 2000 B.C.) alchemical notions had already gathered round gold and lead, gold being regarded as the elixir of life, and lead as the dispeller of sorcery.

The progress of chemistry in India, if it were judged only from the manuscripts still in existence, would appear to have been bound up with the study of medicine. Preparations of mercury and other metals were described, and their use recommended in various diseases, several centuries before the time of Paracelsus, the internal use of the black sulphide of mercury dating from the tenth century A.D. at the latest. There are, however, many signs that the study of metals had already progressed far beyond the knowledge required by the medical practitioners.

Thus in "Rasarnava" (twelfth century) we read "copper yields a blue flame . . . that of the tin is pigeon-coloured; that of the lead is pale tinted," and as another example:—

"A pure metal is that which, when melted in a crucible, does not give off sparks nor bubbles, nor spurts, nor emits any sound, nor shows any lines on the surface, but is tranquil as a gem."

Then there is the Kutab pillar near Delhi, a wrought-iron column which weighs ten tons, and is some 1500

years old, the huge iron girders at Puri, the iron-roofed temple porch at Kanurac, and other relics which show the ancient familiarity of the Hindus with this metal. In the fourteenth century brass and bell-metal were stated to be alloys, and zinc, copper and tin to be metals. The manufacture of gold jewellery is also of great antiquity in India.

Dr. Rāy has ably carried out his task of proving that the ancient lore of the Hindus was far in advance of that of the rest of the world, China excepted. The reader who is unversed in Sanskrit may perhaps be pardoned if he sometimes loses himself for a moment in the maze of Hindu names, and it will be well if his "discerning faculty is nimble and agile, and can suddenly surround a proposition." A glossary would be useful, but could scarcely add to the interest of the volume. The second volume, promised when Dr. Rāy has examined further manuscripts, will be welcome.

T. K. R.

OUR BOOK SHELF.

The Soil: an Introduction to the Scientific Study of the Growth of Crops. By A. D. Hall, M.A. Pp. xiii + 286. (London: J. Murray, 1903.) Price 3s. 6d.

WHEN one who has been for many years both a teacher and an investigator commits to paper the facts and ideas which have formed the substance of his later courses of instruction, we expect a very useful book, and in the present instance we are certainly not disappointed. The book before us takes a wide scope; it deals with the origin of soils, their physical properties, their chemical properties and composition, methods of analysis, the living organisms within the soil, the causes of fertility and sterility, soil types and the natural flora belonging to each. The book is primarily intended for college students. Owing to its wide scope it does not attempt to treat any part of the subject in an exhaustive manner; it possesses, however, the great merits of originality and suggestiveness, virtues which are not always to be found in the formal text-book. A prominent feature of the work is the introduction of the results of investigations carried on by the author while principal of the Agricultural College at Wye. English books on scientific agriculture have hitherto been so necessarily filled with descriptions of foreign researches that any results obtained under English conditions have an exceptional value, and appeal to the farmer in a special manner.

In a work dealing with so many subjects, there are naturally some points open to criticism. The author seems to hesitate in attributing some of the physical properties of soil constituents to their colloid nature, and thus leaves unexplained the enormous amount of hygroscopic water held by humic matter. The indigo method of determining nitrates is mentioned as one that may be used for determining nitrates in soil extracts; the method is, in fact, unsuitable for this purpose, as it gives results much below the truth owing to the presence of organic matter. Nitrification is occasionally spoken of as a kind of "fermentation"; objection may surely be taken to this description. Fermentation is a word of wide meaning, but it surely should not include the oxidation of inorganic matter by a living organism. The chapter dealing with the power of soils to retain various bases and acids is full of interest, yet the theory is incompletely stated, the results of the German, French, and some English investigations on the subject being unnoticed. The laws governing the diffusion of salts, and the results of their molecular diffusion in a moist soil, are also not noticed. The cause of the sterility of alkali lands, and their proper treatment, are, however, well discussed, and many excellent illustrations of the subject are introduced from the experience gained in Egypt.

In a book dealing with many details some slips will inevitably occur; the most important one in the present case is that King's determinations of nitrates in fallow soil appear as determinations of nitrogen as nitrates; the quantity of nitrates present is thus unintentionally much exaggerated.

The concluding chapters on fertility and soil types exhibit most fully the thoroughly practical character of the author's teaching, and will be much valued by many readers. The book is sure to meet with a favourable reception.

R. W.

Electrical Problems for Engineering Students. By W. L. Hooper, Ph.D., and R. T. Wells, M.S. Pp. v+170. (Boston and London: Ginn and Co., 1902.) Price 6s.

THIS is a collection of numerical and mathematical exercises in electrical engineering, starting from the most elementary beginning and ending in the more difficult problems presented by the design and working of direct and alternating current dynamos and motors. The exercises have been tested by the practical experience of the authors at Tuft's College, Mass., and are such as would form a useful accompaniment to a two or three years' lecture and practical course. A distinctly good feature of the book is the number of examples requiring graphical solutions, which cannot fail to impress upon the student the advantages gained by plotting curves. It is always an objection to exercises of this sort that they tend too much to the purely arithmetical and academic side of the subject; thus, many of the problems on subjects which are treated only in an elementary manner in this book are little better than arithmetic sums. For example, in the twelfth chapter, on electrochemistry, there are eleven problems, which are all practically simple proportion sums, and we doubt if the student would gain much more by solving them than he would by solving an equal number of problems on, say, the number of able-bodied men and boys required to till a field. But, if the book be used with discretion, these drawbacks will be lessened, and provided the student is taught in other ways to think about and really understand his subject, these exercises will serve to give him a facility in attacking numerical problems as they arise. The book should prove a useful aid to students and teachers of electrical engineering.

M. S.

Open-Air Studies in Bird Life; Sketches of British Birds in their Haunts. By C. Dixon. Pp. xii+280; illustrated. (London: Griffin and Co., Ltd., 1903.) Price 7s. 6d.

MR. DIXON appears to consider that the appetite of the British public for books on the birds of their own islands is insatiable, and as he seems to find a publisher for all his works on this subject, he is perhaps justified in this opinion. In the present instance the subject is treated from a standpoint somewhat different from the one usually adopted, the birds being described in connection with their environment or "station," instead of systematically. Although this mode of treatment necessarily involves a certain amount of repetition (as in the case of the sparrow and the lapwing), it permits the descriptive side of the subject to be relegated somewhat to the background,

and greater prominence given to habits. So far, however, as we can see, the author appears to have recorded little or nothing new in regard to the latter, and we venture to think that he has missed an opportunity of giving fuller detail as to adaptation to environment, especially as regards coloration. Neither is he to be congratulated as regards his style in many parts of the work, as witness the following sentences in the description of the bearded tit (p. 184):—"The family characters are the same as the generic ones. It is found in various parts of Europe and Asia." It may be also pointed out that "Obb" (p. 261) is not the name of a well-known Siberian river. Again, the introduction of the word "Raptores" in connection with a cut on p. 84 is unnecessary and puzzling, when it is not, so far as we can see, used in the text. And this reminds us that a glossary of *eight* items seems strangely inadequate in a work where a considerable number of technical terms are necessarily employed, for we quite fail to see why it is necessary to explain the meaning of "aftershaft" and leave the reader to find out the signification of "primary."

As regards the illustrations, we have nothing but commendation to bestow, the full-page plates by Mr. Whymper—and especially the one of kingfishers—being exquisite delineations of bird-life. We notice, however, that the small text-figures of birds' heads are for the most part the well-known cuts of Swainson, which were used *with full acknowledgment* by Prof. Newton in his "Dictionary of Birds." Why, we may ask, has the author thought fit to depart from this excellent practice, and to publish the cuts in question as though they were original? R. L.

The Bermuda Islands. By A. E. Verrill, Yale University. (Published by the Author, New Haven, Conn., U.S.A., 1902.)

IN this book, reprinted from the *Transactions* of the Connecticut Academy of Sciences, Prof. Verrill gives an account of the Bermuda group which is intended to subserve four distinct purposes; first, that of a general guide-book on the history, structure, and productions of the islands, for the use of visitors; second, of an introductory text-book to the study of the natural history of the archipelago; third, of a record of the more important changes in the flora and fauna already caused by man; and, lastly, that of a general introduction to a series of more technical memoirs, by the author and other naturalists, on the natural history and geology of the islands, now in course of publication. The present volume includes a general description of the islands, an account of their physical geography and meteorology, a sketch of their discovery and early history, and an account of the animals and plants introduced or exterminated since their discovery by the Spaniards about 1510. The last part of Prof. Verrill's work is of special value, for, so far as appears, no human being had set foot on the islands before that date. Accounts of the geology and marine zoology of the group are promised in a later volume. The book is illustrated by thirty-eight excellent plates, and a large number of cuts, and a valuable bibliography is appended.

La Pratique des Fermentations industrielles. By E. Ozard. Pp. 168. (Paris: Gauthier-Villars, n.d.) Price 2.50 francs.

THIS book is intended specially for the use of brewing chemists. The author gives the essential principles underlying the various fermentation processes, which allow of the transition of sugars and starches into alcoholic products, and also broadly indicates how those processes are carried out in practice.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Psychophysical Interaction.

A BRIEF note to remove a possible misunderstanding suggested by Prof. Minchin. He seems to think, or to imagine that others will think, that when speaking of the action of mind on matter I conceive of mind as a thing that can sustain a "reaction"; so that a stress might exist with matter at one end and mind at the other. Such an absurdity would indeed play havoc with the laws of mechanics; at any rate, I never entertained such a notion for a moment, whether for a guiding or for any other kind of force. If I lift a table it is quite certain that the weight of the table, *plus* its mass-acceleration, is transmitted through my boots to the floor: so far mechanics is supreme. But not even Prof. Minchin could calculate whether I shall lift the table or not, nor what I shall do with it when I have lifted it. I should obey every law of mechanics if I cast it on a bonfire; but I should have interfered with the course of nature, regarded as a mechanically determinate problem, even by only lifting it.

I want to understand the nature of this interference better; I have no other "anxiety" on the subject.

Incidentally I should like to transfer to your pages a most interesting and clearly-worded claim made by Sir W. T. Thiselton-Dyer in to-day's *Times*:—

"Directive power ... wipes out [meaning would wipe out if it were established] ... the whole position won for us by Darwin. It is no use mincing matters. Students of the Darwinian theory must be permitted to know the strength and weakness of their dialectic position. What that theory did was to complete a mechanical theory of the Universe by including in it the organic world." It is the last sentence to which I would direct attention.

Athenæum Club, May 15. OLIVER LODGE.

I AM not clear that it is wise to endeavour to aid Sir Oliver Lodge out of the pit he has, it seems to me, quite unnecessarily fallen into. But I will put a rope down to him, as it must be very uncomfortable down at the bottom.

Almost every mechanical problem leads by the application of ultimate mechanical principles to a differential equation. The solution of this equation involves a certain number of constants which may be infinitely many, but which we always find to be absolutely determined by the initial conditions. At first sight it seems difficult, without tacitly dropping a fundamental mechanical principle—such as that of momentum—to allow for "guidance" and "freewill" therein. But differential equations occasionally admit of *singular solutions*. We may follow up a particular solution, absolutely defined by the initial conditions, until we run onto the singular solution. After this we can stick to the singular solution or leave it again at any other contact with a particular solution, which will still satisfy the fundamental differential equation. Can "guidance" and freewill correspond to a shunt of this kind?

I am quite unaware of any differential equation in mechanics providing a good illustration of this suggestion. Still, we must get Sir Oliver up to the surface again, and this is the only rope by which I can conceive him ascending. κ.λ.π.ν.

"Red Rain" and the Dust Storm of February 22.

THE Marquess Camden recently sent me a sample of fine sand or dust collected from the roof of Bayham Abbey, Lamberhurst, shortly after the great dust storm of February 22, which I have caused to be examined. As the results appear to be of interest, especially in reference to Mr. Clayton's contribution to the *Proceedings* of the Chemical

Society, I should be glad if you could find space in NATURE for an account of them.

The dust consisted essentially of ferruginous sand, chalk, and silicates of alumina, alkalis, lime and magnesia, mixed with a certain quantity of organic matter and with an appreciable proportion of lead.

The last-named substance is probably due to the sample having been collected from a leaded roof. It may either have been scraped off during the taking of the sample, or, possibly, cut from the leads by the impact of sand particles driven against the roof by a high wind. Traces of tin and arsenic were also present in the sample; these were probably contained as impurities in the lead.

The detailed results of the analysis are as follows:—

(Substance dried at 100° C. before analysis.)

	Per cent.
Loss on heating to redness	11·28
Lead, calculated as oxide	3·31
Arsenic	0·01
Tin	Traces

After deducting the lead, tin and arsenic as being probably adventitious, the remainder of the sample is made up of the following constituents:—

	Per cent.
Silica	45·94
Alumina	18·35
Iron oxide	6·57
Lime	8·64
Magnesia	1·86
Alkalis { Sodium oxide	1·16
Alkalis { Potassium oxide	2·30
Carbonic acid	6·10
Water and organic matter	9·08
	100·00

The organic matter contained 2·19 per cent. of carbon and 0·16 per cent. of nitrogen, the two representing, probably, between 3 and 4 per cent. of organic constituents.

After being heated to redness, 33·30 per cent. of the sample was found to be soluble in hydrochloric acid, the dissolved portion including practically the whole of the lead, with the traces of tin and arsenic. Again deducting those elements, the dissolved constituents were as follows:—

	Per cent.
Silica	0·64
Alumina	11·20
Iron oxide	5·43
Lime	8·19
Magnesia	1·13
Alkalis	1·46
Carbonic acid	3·48
	31·53

Thus about one-third of the sample is dissolved by hydrochloric acid, including the greater part of the alumina, iron, lime and magnesia, but only a small fraction of the silica.

Dilute acetic acid readily dissolved out the greater part of the lime, with liberation of carbonic acid gas. Water alone dissolved practically nothing from the sample except minute traces of lime. These results show that most of the lime is present in the sample in the form of chalk.

One or two particles of metallic lead were detected in the sample, together with others partly oxidised and carbonated.

It has been surmised by Dr. Mill and others that the sand which accompanied the storm of February 22, and was observed to fall in a great number of places in this country as well as on the Continent, was originally derived from the African deserts.

It would be interesting in this connection to compare its characters with that of the dust, also presumably of African origin, which was observed to fall in the neighbourhood of Taormina, by Sir Arthur Rücker, and was made the subject of an interesting communication to NATURE by Prof. Judd about a year ago. T. E. THORPE.

Government Laboratories, London, W.C.

The Undistorted Cylindrical Wave.

THE receipt of a paper by Prof. H. Lamb, "On Wave Propagation in Two Dimensions" (*Proc.* Lond. Math. Soc., vol. xxxv. p. 141), stimulates me to publish now a condensation of a portion of a work which will not be further alluded to. I once believed that there could not be an undistorted cylindrical wave from a straight axis as source. But some years ago the late Prof. FitzGerald and I were discussing in what way a plane electromagnetic wave running along the upper side of a plane conducting plate, and coming to a straight edge, managed to turn round to the other side. Taking the wave as a very thin plane slab, one part of the theory is elementary. The slab wave itself goes right on unchanged. Now Prof. FitzGerald speculatively joined it on to the lower side of the plate by means of a semi-cylindrical slab wave. I maintained that this could not possibly work, be ause the cylindrical wave generated at the edge was a complete one, causing backward waves on both sides of the plate. Moreover, it was not a simple wave, for the disturbance filled the whole cylindrical space, instead of being condensed in a slab. It was in the course of examining this question that I arrived at something else, which I thought was quite a curiosity, namely, the undistorted cylindrical wave.

Maxwell's plane electromagnetic wave consists of perpendicularly crossed straight electric and magnetic forces, in the ratio given by $E = \mu v H$. Thinking of a thin slab only, it travels through the ether perpendicularly to itself at speed v, without any change in transit. I have shown that this may be generalised thus. Put any distribution of electrification in the slab, and arrange the displacement $\mathbf{D}$ in the proper two-dimensional way, as if the medium were non-permittive outside the slab. Then put in $\mathbf{H}$ orthogonally, according to the above mentioned rule, and the result is the generalised plane wave, provided the electrification moves with the wave. Otherwise, it will break up. Another way is to have the electrification upon fixed perfectly conducting cylinders arranged with their axes parallel to the direction of propagation.

Now the first kind of plane wave has no spherical analogue, obviously. But I have shown that the other kinds may be generalised spherically. Put equal amounts of positive and negative electrifications on a spherical surface arranged anyhow. Distribute the displacement in the proper way for a spherical sheet, as if constrained not to leave it. Then put in $\mathbf{H}$ orthogonally as above. The result constitutes an undistorted spherical electromagnetic wave, provided the electrification moves radially with the wave, and attenuates in density as its distance from the centre increases, in the proper way to suit $\mathbf{E}$ and $\mathbf{H}$. This attenuation does not count as distortion. Similarly, the other sort of generalised plane wave may be imitated spherically by having conical boundaries.

But when we examine the cylinder, there is apparently no possibility of having undistorted waves. For with a simple axial source it is known that if it be impulsive, the result is not a cylindrical impulse, but that the whole space up to the wave front is filled with the disturbance. It is easy to see the reason, for any point within the wave front is receiving at any moment disturbances from two points of the source on the axis, and there is no cancellation. And if the source be on a cylindrical surface itself, producing an inward and an outward wave, the whole space between the two wave fronts is filled with the disturbance.

How, then, is it possible to have an undistorted wave from a straight line source? By not arguing about it, but by showing that it can be done. The reason will then come out by itself. As the solution can be easily tested, it is only necessary to give the results here. Take plane coordinates r and θ. Let the magnetic force be perpendicular to the plane, of intensity H. Let Z be its time-integral, then

$$Z = \frac{\cos\frac{1}{2}\theta}{v r^{\frac{1}{2}}} f(vt - r), \qquad H = \frac{\cos\frac{1}{2}\theta}{r^{\frac{1}{2}}} f'(vt - r), \qquad (1)$$

expresses the magnetic field, f being an arbitrary function. Now the displacement $\mathbf{D}$ is the curl of $\mathbf{Z}$. So if E_1 is the radial component of $\mathbf{E}$, and E_2 the tangential component, in the direction of increasing θ, we have the electric field given by

$$E_1 = \frac{-\mu v \sin\frac{1}{2}\theta}{2r^{\frac{1}{2}}} f, \qquad E_2 = \frac{\mu v \cos\frac{1}{2}\theta}{r^{\frac{1}{2}}} f' + \frac{\mu v \cos\frac{1}{2}\theta}{2r^{\frac{1}{2}}} f. \qquad (2)$$

The attenuation factor $r^{-\frac{1}{2}}$ in (1) does not count as distortion.

The wave may go either way, and various cases can be elaborated. If the wave is outward, the axis ($r=0$) is the source. The plane $\theta=0$ is a perfect electric conductor. The electrification is of the same sign on its two sides. Other details may be got from the formulæ.

I give an example to show the not very obvious electrical meaning. Let the infinite plane conductor with the straight edge be one pole of a condenser, and a straight wire placed parallel to the edge, and close to it, be the other pole. Join them by a battery, charging the plate and the wire. Bring the wire right up to the edge, and reduce its magnitude to a mere line. (This is to be done in order to attain the ideal simplicity of the formulæ.) Take away the battery. Then the electric field is given by

$$cv\mathrm{E}_1 = -\frac{\sin\frac{1}{2}\theta}{2r^{\frac{1}{2}}}f_0, \qquad cv\mathrm{E}_2 = \frac{\cos\frac{1}{2}\theta}{2r^{\frac{1}{2}}}f_0, \tag{3}$$

where f_0 is a constant and c is the permittivity.

Finally, discharge the condenser by contact between edge and wire. Then the result at time t later is that outside the cylinder of radius $r=vt$ the above field (3) persists, whilst inside the cylinder there is no **E** or **H**. An electromagnetic wave separates these regions. It started from the axis at the moment of contact, and as it expands swallows up the whole energy of the field, and carries it to infinity. Similarly, as regards the charging of the plate, only the "battery" should, to have the same formulæ, be an impressed force acting at the axis, between the edge and the wire. At time t after contact, the electric field is established fully within the cylinder $r=vt$. On its boundary is the impulsive wave which is laying down the remainder. It also, if the contact be instantaneous, wastes an equal amount of energy at infinity.

Similarly, by varying the impressed voltage anyhow with the time, the emission of an arbitrary wave of **H** results. With a real plate and real wire, the main features would no doubt be the same. The use of the line wire introduces infinite voltage.

What somewhat disguises the electromagnetics is the existence of the steady electric force, or parts thereof, along with the electromagnetic **E** and **H**, particularly when f is arbitrary. There is a similar complication in the spherical wave when the total electrification in any thin shell is not zero. There is then an auxiliary internal or external electric force to make continuity.

We cannot have an undistorted wave from a simple line source. But in the example the apparent line source will be found to be a doublet. For the curl of **e** (impressed force) is the source of the wave. It is double, positive on one side, negative on the other.

Solutions of the type

$$\mathrm{H} = \Sigma\frac{\mathrm{A}r^{n}\cos(n\theta+a)}{(v^2t^2-r^2)^{n+\frac{1}{2}}} \tag{4}$$

or the same with r and vt interchanged in the denominator, are not distortionless, save for the solitary term in which $n=-\frac{1}{2}$. The above distortionless cylindrical wave (1) is unique. Prove by the characteristic.

April 29. OLIVER HEAVISIDE.

Seismometry and Geite.

UNDER the above heading Prof. J. Milne contributed an interesting article to NATURE of April 9, p. 538, on which I wish to offer some remarks. Prof. Milne seems hardly to realise the significance of the enormous pressures to which the earth's deep-seated material is presumably exposed. One of his objections to the hypothesis of an iron core seems to be that the wave velocities for an infinite isotropic medium of the density and elasticity of iron do not accord with the velocities of earthquake waves. This objection, however, is not conclusive. In an infinite isotropic medium there are *two* purely elastic wave velocities, v_1 and v_2, given by the equations

$$v_1 = \sqrt{(m+n)/\rho}, \quad v_2 = \sqrt{n/\rho},$$

where ρ is the density, m and n Thomson and Tait's two elastic constants. On the ordinary theory, n/m may possess any value consistent with Poisson's ratio γ, or $(m-n)/2m$, lying between 0 and 0·5. Six years ago I showed (*Phil. Mag.*, March, 1897, p. 199) that observed seismic wave velocities can be accounted for by elastic waves without postulating any abnormal value for Young's modulus—the modulus to which Prof. Milne repeatedly refers. For instance, we get values of 12·5 and 2·5 kilometres per second respectively for v_1 and v_2 in a medium of density 5·5 with a Young's modulus of only 10^9 grammes weight per sq. cm., if we suppose $n/m=1/24$, or $\gamma=0{\cdot}48$ approximately; and the same results follow if we increase density and elastic constants in the same proportion.

In iron, as we know it, γ, of course, is not 0·48, but more nearly 0·25. A material, however, which under low pressures has $\gamma=0{\cdot}25$, *may*, after prolonged exposure to enormous pressures, behave as an elastic medium with γ very nearly 0·5. In fact, if the deep-seated material acts as an elastic medium, the only consistent way yet pointed out for its doing so is by its behaving as if γ were very near the limiting value answering to incompressibility. Neither of the elastic wave velocities, it should be noticed, has anything directly to do with Young's modulus, a point which cannot be too clearly emphasised. Another consideration is the possibly appreciable influence of gravity on the wave velocities.

Coming now to the question of the behaviour of magnetographs at times of seismic disturbance, there must undoubtedly be magnetic disturbances occasioned by earthquakes in more than one way. When a violent earthquake occurs where magnetic material abounds, there may be a vast movement of magnetised matter; there may be a great change in the stresses throughout adjacent magnetic material; and there may be a great change of local temperature. Any one of these causes will give rise to a magnetic disturbance which should be practically simultaneous all over the world, and should *precede* any seismic movement at distant stations. It should also diminish very rapidly as the distance from the earthquake origin increases.

Again, as the seismic waves travel out from their source they must cross volumes of magnetic matter, and the mechanical effect on any such volume must necessarily produce changes in its magnetic field. Owing to the finite velocity of seismic waves, the displacements and stresses simultaneously existent in different parts of any large magnetic volume must be in all kinds of phases, leading to considerable interference between the magnetic disturbances to which the different parts give rise at any considerable distance. Thus the most plausible explanation of why a magnetic disturbance of some prominence—if real—should appear at one observatory, but not at another only 100 miles off, is certainly the existence of magnetic material close to the former. Supposing that such local material exists, the magnetic phenomena may be expected to vary according to the direction in which the earthquake wave is travelling.

One of the chief difficulties in reaching definite conclusions is the contracted time scale usual in magnetograms. If the true seismic and the apparent magnetic disturbances occur within a few seconds of one another, it is usually practically impossible to say which is the earlier. To see the full force of this, one must remember that a by no means improbable explanation of why apparent magnetic disturbances accompany earthquakes at one station, but not at another, is that the magnets at the former, owing to pattern or site, may be much more sensitive *seismographs* than those at the latter.

Again, it must be remembered that whilst the so-called "large waves"—rather an unfortunate term—produce in general a much greater effect on a horizontal pendulum than do the "preliminary tremors," it by no means follows that the same will be true of either the true magnetic or the purely mechanical effects on a magnet. Much may depend on the method of support and the time of swing.

The passage of the "preliminary tremors" and "large waves" due to an earthquake often occupies several hours, and during this interval several true independent magnetic movements are not at all unlikely to present themselves, even at times of general magnetic calm.

For all these reasons a careful intercomparison is wanted of magnetic and seismic records from a variety of stations. Something might be done by running magnetographs for some time in a district where a local magnetic disturbance

is known to exist, and contrasting the results with those obtained elsewhere with the same instruments.

Prof. Milne mentions Kew and Greenwich as representatives of stations where magnetic and gravitational anomalies do not exist, but, as a matter of fact, Rücker and Thorpe's magnetic survey does show a small magnetic anomaly in the Thames Valley, and certain foreign observers have also inferred a gravitational anomaly.

As to Prof. Milne's special term "gēite" for material in the earth's interior, I must confess that the application of a new word to the unknown material of a problematical core seems to me more likely to hinder than assist. Such special terms constitute an additional obstacle in the way of those who are not specialists. Also existing terms, such as nucleus and core on the one hand, and layer or crust on the other, seem not inadequate, the context showing whether it is the material that is immediately in view.

I have had repeated occasion to deal with elastic problems involving a core and a layer or layers. In fact, the very "earth" for which Prof. Milne expresses a preference, consisting of a layer of about 1/20 of the earth's radius in thickness with a density of average surface rock, and a core of specific gravity approaching 6, is one which I selected some years ago for the purpose of investigating luni-solar tidal action (*Cambridge Phil. Trans.*, vol. xvi. p. 151). Thus I do not speak without experience.

A final point to be remembered is that, according to the investigations of Gauss and others, the earth itself is a magnet of considerable moment. Any theory which claims even provisional acceptance may be expected to give a plausible explanation of this fact, and of the secular change observed in terrestrial magnetism. C. CHREE.

Photograph of Oscillatory Electric Spark.

THE enclosed photograph of an oscillatory electric spark, like most of those which I have taken, differs in some respects, so far as I have seen, from those which have been recorded by other experimenters. It was obtained by the discharge of 22 square feet of coated surface through

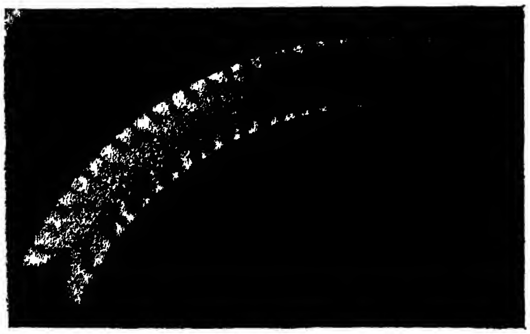


FIG. 1.—Oscillatory electric spark.

¼ mile of coiled wire, the electrodes being of magnesium. The picture was focused on a circular plate fixed on the end of an electric motor, so as to revolve in its own plane. The number of double oscillations was about 3000 per second. C. J. WATSON.

Bottville Road, Acocks Green, Birmingham.

Our Rainfall in Relation to Brückner's Cycle.

IN the instructive paper on solar and meteorological changes in NATURE (May 7), I observe that Dr. Lockyer suggests 1913 as probably about the centre of the next wet period. A consideration of barometric changes appears to lead to a similar result, and I may be permitted to recall a letter sent you in 1898 (NATURE, December 22, p. 175), in which, discussing with such data the question, "Where do we stand in Brückner's cycle?" I mentioned 1911 as probably near that centre. Such estimates must, of course, be regarded as merely approximate, and open to revision.

This important cycle of Brückner's was lately discussed in a number of letters to the *Times*, and it is satisfactory to see that more adequate attention is now, though tardily, being given it.

Is it not objectionable to treat the British Isles as a whole, since, on Brückner's theory, the western portion shows opposite variation to the eastern?

There is a method of curve-making which seems to be little used by meteorologists, but which is, I think, to be recommended. A series of annual rainfall figures (say) is first translated into a series of plus and minus values (related to the average), and this series is then added algebraically step by step, *e.g.*

$$+9{\cdot}3-1{\cdot}4+0{\cdot}6+0{\cdot}9-1{\cdot}6+1{\cdot}3, \text{ \&c.}$$
$$+7{\cdot}9+8{\cdot}5+9{\cdot}4+7{\cdot}8+9{\cdot}1, \text{ \&c.}$$

This second series is then thrown into curve form. The process is analogous to paying in money to a bank, and drawing money out, and the point reached by the curve at any given time indicates the balance.

Each upward (annual) extension in such a curve represents a wet year, and each downward extension a dry year, and the degree of wetness or dryness is also indicated.

A large comparison of such curves for European and other stations would, I think, throw a good deal of light on the Brückner theory. ALEX. B. MACDOWALL.

The Propagation of Phthisis.

IN a work called "Opera nuova intitulata il Perche, utilissima ad intendere le cagioni de molte cose, &c.," published in Venice in 1520, the following passage occurs:—"Dal sputo del Tisico o da la sua boca viene fuora un vapore fetido e acuto che entra poi per la boca de colui che conversa con quello e corrode simelmente il pulmone de esso e in questo modo genera tisica."

Substitute for *vapore* "material particles," and we have the modern conception of the mode of propagating consumption. This anticipation of modern science seems worthy of note. EDMUND MCCLURE.

TANGANYIKA.[1]

THE title of this work is perhaps somewhat misleading. The reader who expects the book to contain only discussions of speculative questions will be agreeably surprised by finding that the positive contributions made in it to our knowledge of the geology, botany and zoology of Central East Africa are of the most extensive and valuable character. The two expeditions which the author undertook in 1896 and 1899 to Lake Tanganyika and the surrounding districts, following upon the researches of earlier travellers, have thrown a flood of light upon both the geological structure and the fauna and flora of this part of the world, while they have incidentally suggested a number of difficult problems of no small interest alike to the geologist and the biologist.

The surveys of Mr. Moore and of Mr. Malcolm Ferguson, the geologist who accompanied him, have been of value in rectifying and making noteworthy additions to the maps of the area visited. The geographer will find references to a number of new mountain peaks, the heights of many of which are given, with the determination of the heights above sea-level and the depths of many of the lakes, in several of which numerous soundings and dredgings were made.

One of the most valuable results of Mr. Moore's explorations is the confirmation he is able to supply to the conclusions of Mr. Scott Elliot that there exists in East Central Africa a great mountain chain running north and south, and rising at many points, even in this Equatorial region, above the limits of perpetual snow. The height of the snow-line is fixed by Mr.

[1] "The Tanganyika Problem; an Account of the Researches undertaken Concerning the Existence of Marine Animals in Central Africa." By J. E. S. Moore, F.R.G.S., author of "To the Mountains of the Moon." Pp. xxiii + 371; with 7 maps and 140 illustrations. (London: Hurst and Blackett, Ltd., 1903.)

Moore at 13,500 feet, and some of the peaks he thinks may attain a height of 16,500 feet, while Sir Harry Johnston believes that 20,000 feet is a probable minimum of the height of some of them. This great mountain chain, giving rise in some parts of its course to numerous glaciers—the "Mountains of the Moon" of the ancients—Mr. Moore proposes to call "the Great Central African Chain." It extends from the mountains of Abyssinia in the north to the Drakensberg in South Africa, though in some places, as in the neighbourhood of Tanganyika and the Albert Edward Nyanza, it is a broad ridge, the culmination of long eastern and western slopes, rather than a conspicuous chain; so that, viewed from either side, it has little resemblance to a mountain range, even when its summits rise ten or twelve thousand feet above the sea-level.

Mr. Moore discusses the geological structure of this great mountain chain, giving a number of valuable geological sections across it at various points. The origin of the range, he believes, must be assigned to lateral compression, the celebrated "rift-valleys" being regarded by him as subordinate features resulting from the orographic movements in the earth's crust. Although volcanic action has only played a subordinate part in the formation of the great chain itself, in the greater portion of its course, yet in the district lying to the north of Tanganyika, which was carefully explored by our author, we have the still active volcanic district of the Mfumbiro Mountains, a chain of volcanoes running east and west; the highest of these, Karisimbi, is often snow-capped, and has a height of 14,000 feet. Mr. Moore shows that the structure of the great longitudinal valley in which Tanganyika lies has been profoundly modified by the ejection of the materials forming the Mfumbiro chain. The surface of Lake Kivu, to the north of Tanganyika, is 4841 feet above sea-level, while Albert Edward Nyanza, still further north, lies 2000 feet lower, and Tanganyika has a height of 2700 feet. The author points out that previously to the formation of the Mfumbiro volcanic cones, the waters of Lake Kivu must have drained northwards into the Albert Edward Nyanza, and not, as now, into Lake Tanganyika, by the Russisi River. Numerous other volcanic cones occur in the district, generally at the bottom of the rift-valleys. The waters of Lake Kivu contain such a large amount of salts that the pebbles and reeds on the shores become encrusted with a calcareous deposit, which analysis shows to contain 12·66 per cent. of magnesium to 28·65 of calcium. The waters of Lake Kivu, which is sometimes more than 100 fathoms deep, have been analysed and found to contain a very large proportion of magnesium carbonate.

The geological formations met with in the expeditions, the distribution of which in the neighbourhood of the several lakes is shown upon sketch-maps, are as follows, beginning with the oldest:—

(1) Old crystalline rocks—granite, gneisses, schists, quartzite, &c.

(2) Great thickness of unfossiliferous sandstones and shales.

(3) "Drummond's beds," a series of sandstones and shales of about the age of the Trias.

(4) Recent lacustrine strata.

Unfortunately, no satisfactory evidence has yet been adduced as to whether the stratified rocks (2) and (3) can, either or both of them, be regarded as of *marine* origin, and some of the unsolved problems of African geology must await full solution until this determination has been made. At present we have no proof that the stratified masses of the older formation are not, like those of the younger, of lacustrine or fluviatile origin.

Around some of the great Central African lakes there are found extensive alluvial deposits containing the shells of species of Mollusca, which still live in the waters of the adjoining lake. These, with the numerous raised beaches, show that some of the lakes had formerly a much greater extent than at present. It is upon these old alluvial deposits that the celebrated "Park-lands," so well described and so convincingly explained by Mr. Moore, are found. Among the botanical results of the two Tanganyika expeditions, not the least valuable are the investigation of these curious features that have attracted so much attention from all travellers in the district. Mr. Moore shows how the springing up of scattered individuals of the hardy euphorbias has afforded a shade under which plants less able to withstand the burning heat of the sun have grown up and gradually extended outwards. Of course, in the end, these outward spreading patches of vegetation must coalesce and form a tangled forest growth, such as occurs in other parts of Central Africa. Mr. Moore ingeniously argues that the amount of development towards this forest growth may be utilised as a means of determining the geological age of the alluvial flats upon which they are found.

It is on the zoological results of these expeditions, however, that the author of the work before us must be especially congratulated. The addition of nearly 200 species of animals to the fauna of the district is the least important of his achievements, though it shows how assiduous and successful must have been his work as a collector. But Mr. Moore is far more than a collector. By careful observations and experiments carried on during his residence among the lakes, by his studies of living animals in their peculiar environment, and by his work in the laboratory upon the specimens he has brought home, he has made the most substantial additions to zoological science.

On questions of distribution the researches of Mr. Moore have a very important bearing. The discovery by Speke and the missionaries of marine types of mollusca in the waters of Tanganyika, followed as it was by Boehm's discovery of a medusa in the same fresh waters, made it a question of first importance to determine whether the same phenomena were exhibited in any other of the African lakes. To this question Mr. Moore has afforded a complete answer. He has himself examined the faunas of lakes Shirwa, Nyassa, Kela, Tanganyika, Kivu, the Albert Edward Nyanza, the Albert Nyanza, the Victoria Nyanza, and Nivasha. The faunas of four or five more lakes are less perfectly known from the work of other travellers, and it is now certain that the peculiar "halolimnic fauna," as Mr. Moore calls it, is confined to Tanganyika, all the other neighbouring lakes containing only the ordinary types of fresh-water mollusca and fish that occur in similar situations all over the globe. The account given of the distribution of these forms by Mr. Moore, especially in the salt lake of Shirwa, will prove of interest both to zoologists and to geologists.

The fish-fauna of Tanganyika consists of eighty-seven species, of which no less than seventy-four are new to science, and have been described and figured by Mr. Boulenger. The medusa (*Limnocnida tanganyicae*) of Tanganyika has been described from spirit specimens by Mr. Robert Günther, of Oxford; but Mr. Moore has been able, during his residence at the lake, to make drawings of the living animal, to work out its development, and to add much to our knowledge of its habits. We reproduce his drawings of this curious organism, which varies in size from a shilling to a two-shilling piece.

The complete study of the anatomy of the "halolimnic" gasteropods, which so closely resemble marine forms of the Jurassic period, has been carried out by

Mr. Moore and fellow-workers in the Royal College of Science, and a curious form of polyzoan, with some prawns and sponges, have been added to the fauna with marine affinities that have made Tanganyika so interesting to naturalists.

Want of space forbids our entering on a discussion of the theoretical questions dealt with in the work

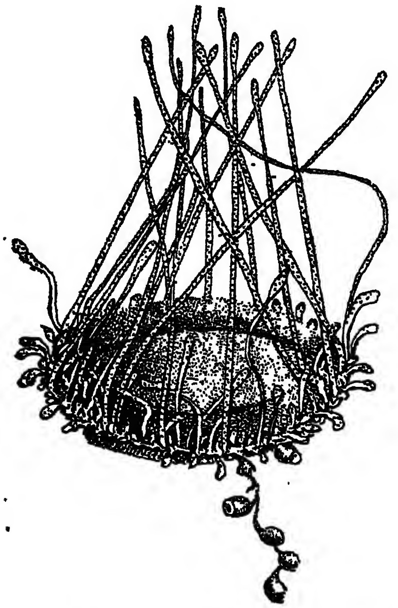


Fig. 1.—Living asexual adult of the Tanganyika medusa, enlarged about one-third. To the right is seen a string of buds becoming detached.

before us. On many of these the last word has not been said, and some of the speculations put forward by the author can be regarded as having only the value of ingenious suggestions. In dealing with so large a mass of new and varied material, the author may have been led in places to express hasty judgments,

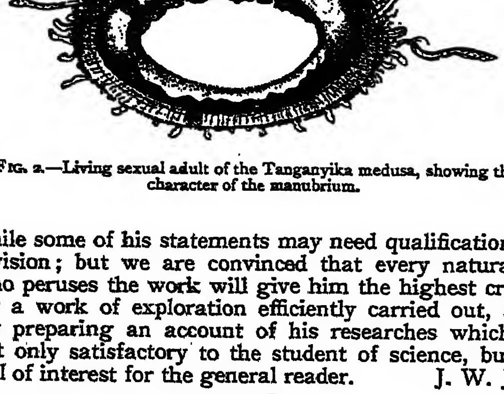


Fig. 2.—Living sexual adult of the Tanganyika medusa, showing the character of the manubrium.

while some of his statements may need qualification or revision; but we are convinced that every naturalist who peruses the work will give him the highest credit for a work of exploration efficiently carried out, and for preparing an account of his researches which is not only satisfactory to the student of science, but is full of interest for the general reader. J. W. J.

ENLARGEMENT OF THE KEW HERBARIUM.

Sir William J. Hooker, the first director of Kew Gardens, as a public establishment, was really the founder of the herbarium at Kew, for before any bequests or gifts were made, his extensive private collection of dried plants and books was, by arrangement with the Government, used for the purposes of the gardens, and accessible to botanists of all countries. When Sir William took up his appointment in 1841, there was neither specimen nor book the property of the garden, and his herbarium and library were first deposited in his own residence at West Park. In 1853 his herbarium and a portion of his library were lodged in the original portion of the present block of buildings, and he received a small annual grant from Government for assistance and maintenance, on the condition that the plants and books were free to other botanists. The same year Miss Bromfield presented the herbarium and library collected by her deceased brother, W. Arnold Bromfield, the author of the "Flora Vectensis," which was edited after his death by Sir Joseph Hooker.

This gift, though not so extensive as some subsequent ones, was very valuable, both in plants and books, the latter including a number of excellent copies of the best editions of many of the early authors, or "old masters." The following year, 1854, Mr. George Bentham presented his very rich herbarium and library to the nation, on the condition that they should be deposited at Kew, and so housed and arranged as to be accessible to himself and other botanists. I may add, parenthetically, that Bentham continued his botanical work at Kew, almost uninterruptedly, for thirty years, the end of which saw the completion of the "Genera Plantarum" of Bentham and Hooker, a work which has not yet been replaced by an equally concise and useful synopsis of a uniform character. Sir William Hooker died in 1865, and in 1866 the Government purchased his herbarium and library, so far as they were not already represented in the national collection at Kew. This purchase included museum specimens, drawings, manuscripts, portraits of botanists, and Sir William's botanical correspondence, covering a period of sixty years. As is well known to the older generations, Sir Joseph Hooker succeeded his father in the directorship, and he in turn was succeeded by his son-in-law, Sir William Thiselton-Dyer, the present director.

Under these successive directors, due greatly to their activity and zeal, the collections of plants and books have continued to increase with great rapidity, partly from increasing Government grants, and partly from private munificence. Among the latter the collections specially deserving mention are:—A. Cunningham's Australasian; Burchell's St. Helena, S. African and S. American; Borrer's British; H. C. Watson's British; Miss Griffith's Algæ; Wight and Rottler's Indian; Boott's Carices; J. Gay's general, presented by Sir Joseph Hooker; Ball's general herbarium and botanical library; Carey's N. American; and quite recently Dr. Alexander Prior's general herbarium, received through Sir Prior Goldney.

All these important gifts consist mainly of named and mounted specimens. Smaller donations number many hundreds. The enormous Indian collections of Hooker and Thomson reached Kew in 1851. They were estimated at 8000 species, and the specimens were so numerous that no less than sixty sets were given away to other botanists and botanical establishments. The distribution of these specimens, and seven wagon-loads of specimens (chiefly of Griffith, Helfer and Falconer's collecting) received from the India House in 1858, was not completed until 1863.

The rapid growth of the herbarium and library neces-

sitated enlargement of the building about twenty-five years ago, when a large hall was added. This is a quadrangular structure eighty-six feet by forty-three feet, with a ground floor and two galleries connected by two spiral staircases, and lighted by forty-eight windows. A second hall of the same dimensions has just been completed, and will soon be occupied. It is connected with the old hall on each floor by a corridor fifty-six feet long, and the floors and roof are of concrete, and it is intended to replace those of the old hall with the same material at once. It is estimated that the entire collection comprises considerably more than 2,000,000 specimens, attached to 1,300,000 sheets.

With the exception of Carey's North American herbarium, Lindley's orchids, and Borrer and Watson's British herbaria, the plants from all parts of the world are arranged in one series, the genera according to Bentham and Hooker's "Genera Plantarum," and the species geographically. It is unnecessary to enlarge on the value of a herbarium containing the types of all the colonial floras and other works issued from Kew—it is known to all botanists. The library, which the present director has made his special care, is one of the richest, even if not the richest, in existence, and is in admirable condition. It comprises upwards of 20,000 volumes, besides about 10,000 pamphlets. The Government published a catalogue of the books in 1899, and annual supplements since. There is also a separate collection of about 100,000 published figures and original drawings of plants.

W. Botting Hemsley.

THE SOUTH AFRICAN ASSOCIATION.

The inauguration of the South African Association for the Advancement of Science took place at Cape Town on April 27. The *Cape Times*, to which we are indebted for the details of the proceedings, describes the successful gathering as a British Association meeting in miniature. The new Association enters upon its career with a membership of seven hundred persons from many parts of South Africa.

The main objects of the organisation are the same as those of the parent body. As defined in the Constitution, they are "to give a stronger impulse and a systematic direction to scientific inquiry; to promote the intercourse of societies and individuals interested in science in different parts of South Africa; to obtain a more general attention to the objects of pure and applied science, and the removal of any disadvantages of a public kind which may impede its progress."

The presidential address was delivered by Sir David Gill, K.C.B., the Astronomer Royal for South Africa, who explained the nature of the work which it was hoped the new Association would accomplish. During the course of his able address Sir David Gill announced that Lord Kelvin had written that, although in 1905 he will be eighty-one years of age, he intends, if he is as well then as he is now, to accompany the British Association on the visit to South Africa.

The work of the sections began on the second day of the meeting. The presidential addresses in the various sections were delivered by the following men of science:—

Section A.—Astronomy, Chemistry, Mathematics, Meteorology, and Physics, by Prof. P. D. Hahn; Section B.—Anthropology, Ethnology, Bacteriology, Botany, Geography, Geology, Mineralogy, and Zoology, by Dr. R. Marloth; and Section C.—Archæology, Education, Mental Science, Philology, Political Economy, Sociology, and Statistics, by Dr. Thomas Muir, C.M.G., F.R.S., Director of Education for Cape Colony.

Among the papers read during the course of the meetings the following deserve mention. In Section A, on ferments causing "casse" in wine, by Mr. Raymond Dubois; meteorology in South Africa: a retrospect and prospect, by Mr. C. M. Stewart; close binary systems, by Dr. Alex. W. Roberts; determination of mean temperature, &c., from observations made at second-order stations on the Table Land, by Mr. J. R. Sutton; some recent work on the discharge of electricity from heated bodies, by Prof. J. C. Beattie.

In Section B, (1) on the occurrence of an epidemic among the domesticated animals in Mauritius in which Trypanosomata were found in the blood; (2) note on the co-relation of several diseases occurring among animals in South Africa; (3) on the production of a malarial form of South African horse sickness, by Dr. Alex. Edington; the minerals of some South African granites, by Mr. F. P. Mennell; on the classification of the Theriodonts and their allies, by Dr. R. Broom; (1) some morphological and biological observations on the genus Anacampseros; (2) on some stone implements in the Albany Museum, by Dr. S. Schonland.

In Section C, some aspects of South African forestry, by Mr. D. E. Hutchins; dry crushing of ore preparatory to the extraction of gold, by Mr. Franklin White; sewage disposal in Cape Colony, by Mr. J. Edward Fitt.

In Section D, the library system of South Africa in comparison with those of England and America, by Mr. Bertram L. Dyer; iteration as a factor in language, by Prof. W. Ritchie; common sense and examination, by Mr. P. A. Barnett; Cape Dutch, by Prof. W. S. Logeman; how we get knowledge through our senses, by Rev. Dr. F. C. Kolbe.

The example set by the British Association of arranging for receptions and other social functions to lighten the intellectual fare provided was followed at Cape Town, and the excursions, conversazioni, &c., were well attended and much appreciated.

THE ROYAL SOCIETY CONVERSAZIONE.

The conversazione held at the Royal Society on Friday last was attended by a large and distinguished company, among the visitors being H.R.H. the Prince of Wales and H.S.H. the Duke of Teck. There were numerous exhibits illustrating progress in various branches of science, several of them being of great interest. Following our usual course, we abridge the particulars given in the descriptive catalogue as to the character and purpose of the objects on view.

Sir William Crookes, F.R.S., exhibited objects illustrating certain properties of the emanations of radium. If a solid piece of radium nitrate is brought near a blende screen, and the surface examined with a pocket lens magnifying about 20 diameters, scintillating spots are seen to be sparsely scattered over the surface. On bringing the radium nearer the screen the scintillations become more numerous and brighter, until when close together the flashes follow each other so quickly that the surface looks like a turbulent luminous sea. A convenient way to show these scintillations is to fit the blende screen at the end of a brass tube with a speck of radium salt in front of it and about a millimetre off, and to have a lens at the other end. Focusing, which must be accurately effected to see the best effects, is done by drawing the lens tube in or out. It is proposed to call this little instrument the "Spinthariscope."

Specimens of brittle gold and photographs illustrating their microstructure were shown by Dr. T. K. Rose. Gold of the British imperial standard, containing 91·6 per cent. of gold and 8·3 per cent. of copper, is made brittle and unfit for coinage by the presence of minute traces of certain impurities such as tellurium, lead, bismuth, &c. Similar or even considerably greater quantities of these elements, excepting bismuth, do not affect the ductility of fine gold. The deleterious effects of the impurities are removed by the presence of oxide of copper dissolved in the metal. The changes in the quality of coinage bars are accompanied by profound changes in the microstructure of the metal.

Dr. Morris W. Travers exhibited hydrogen thermometers for measuring low temperatures. The thermometers are of the constant-volume type, and are intended for the

measurement of temperatures between 0° and −253° C. One is graduated directly in degrees on the hydrogen scale, and can be employed for the direct measurement of low temperatures to within one degree. The other is intended for more accurate measurements.

A new coherer, as applied to wireless telegraphy, was shown by Sir Oliver Lodge, F.R.S., and Dr. Alexander Muirhead. A steel wheel rotates so that its edge touches a pool of mercury through a film of oil. (See *Proc.* Roy. Soc., March.) This is the coherer, and its decoherence is automatic. A fraction of a volt is used in the detecting circuit, which works a siphon recorder as the receiving instrument. The sending part of a station, including an automatic transmitter and a "buzzer" for carving a steady current into intermittencies, was also shown.

Incandescent oil burners were exhibited by Mr. T. Matthews. These burners have been designed by the exhibitor primarily for use in the Trinity House Lighthouse Service. The intensity of the single mantle burner for flashing lights is 1100 candles, and the consumption of oil one pint per hour; the intensity of the triple mantle burner for fixed and occulting lights is 2700 candles, and the consumption of oil three pints per hour, the flashing point of the oil being in each case from 145° to 160° Fahrenheit (close test).

Experiments on controlling and regulating spark discharges, shown by Mr. Alfred Williams, illustrate how the use of a shunt, or of a point and shunt, or of plates of high resistance, so influence the field in a spark gap that the discharges are made more regular and placed more under control for therapeutic and wireless telegraphy purposes.

The "Elasmometer," a new form of interference apparatus for the determination of the elasticity of solid substances, was exhibited by Mr. A. E. Tutton, F.R.S. The apparatus is designed to measure the amount of bending suffered by a thin plate of the substance investigated, when supported near its ends against a pair of platinum-iridium knife-edges, under a weight applied at its centre.

Prof. A. G. Greenhill, F.R.S., showed a gyroscopic pendulum, for lecture experiment. A bicycle wheel is suspended by a prolongation of its axis from a universal joint, formed with a hub and its ball-bearings. The wheel is rotated by a stick inserted in the spokes, and projected to illustrate the variety of gyroscopic motion.

Dr. W. Ramsden demonstrated by experiments and illustrated by photomicrographs and specimens, the presence and spontaneous formation of solid membranes upon the free surfaces of certain solutions. He also showed that solid membranes are present on certain bubbles.

Aërial photographs were shown by the Rev. John M. Bacon. Among the pictures was one showing the sea bottom at a depth of ten fathoms photographed from an altitude of 600 feet.

The physical sciences were also represented by the following objects and experiments:—A series of photographs and objects relating to Dr. William Gilbert, of Colchester (1544–1603), author of the treatise "De Magnete," Prof. Silvanus P. Thompson, F.R.S.; a direct vision spectroscope of one kind of glass, and of minimum deviation for any ray in the centre of the field of view, Mr. T. H. Blakesley (see p. 71); apparatus for the detection and estimation of minute quantities of arsenic in beer and brewing materials, as recommended by a Departmental Committee of the Board of Inland Revenue, Prof. T. E. Thorpe, C.B., For.Sec.R.S.; ephelkystika, or tractate curves, and machine for drawing them, Col. Hippisley, C.B., R.E.; (1) gravimetric recording hygrometer, (2) an electrical dewpoint hygrometer, Prof. F. T. Trouton, F.R.S.; Callendar's compensated barometer, Mr. N. Eumorfopoulos; light mirrors, suitable for galvanometers (see p. 72), Mr. W. Watson, F.R.S.; micrometer for measuring screws, made for the British Association Screw Gauge Committee, the Cambridge Scientific Instrument Company; photographs of dust deposits, Dr. W. J. Russell, F.R.S.; examples of Lippmann's process of photography in colours, Mr. Edwin Edser and Mr. Edgar Senior; an experiment illustrating the conductivity imparted to a vacuum by hot carbon, Mr. O. W. Richardson; a high pressure spark-gap used in connection with an inductor of the Tesla type, and also in connection with a radiator of Hertzian waves, Rev. F. J. Jervis-Smith, F.R.S.; diagrams illustrating the order and origin of the musical scales, Mr. Joseph Goold.

An artificial horizon attachment to sextants, exhibited by Commander Campbell Hepworth, C.B., consists essentially of a contact maker, operated by a plummet mounted on a sextant, and connected with a galvanic battery. It is so adjusted as to close the circuit and ring a bell when a slit or line on the horizon glass is in alignment with the eye of the observer and the sensible horizon. Observations for latitude and longitude at sea are rendered impossible when the natural horizon is obscured by fog or mist, although sun, moon, or stars may be shining clearly; but with the aid of this instrument the observer may obtain the true altitude of a heavenly body within five minutes of arc.

The Solar Physics Observatory, South Kensington, exhibited (1) photographic comparison of the arc spectra of various samples of dust; (2) curves, illustrating the long period solar and meteorological (rainfall) variations of about thirty-five years; (3) photographs of new curved slit by Hilger. This slit is used at the focus of the second objective of the photo-spectro-heliograph, and is intended for the isolation of the K (calcium) line in the solar spectrum, Nos. 3 *a* and *b*.

The use of a colour screen in photographing bright stars was illustrated by the Cambridge Observatory. By the use of a yellow spot on a worked glass screen in contact with the sensitive plate, the image of a bright star can be reduced to equality with the images of the comparison stars. It thus becomes possible to apply photography to the determination of the parallaxes of bright stars, which have been dealt with hitherto almost entirely by the heliometer.

The chromospheric spectrum near the South Pole of the Sun was shown by Mr. J. Evershed. Nebular spectra of Nova Persei from May 3, 1901, to January 14, 1902, with previous spectra for comparison, were illustrated by Mr. Frank McClean, F.R.S. Other exhibits were:—(1) collimating gun sight for day and night; (2) optical sight for guns and rifles; (3) spherometer of great delicacy, by Dr. A. A. Common, F.R.S.

Methods of disintegrating cells and microorganisms, and of obtaining their intracellular constituents, were shown by Dr. A. Macfadyen and Mr. S. Rowland. In the first method the cells are disintegrated by the violent impact of sand particles in the apparatus exhibited. In the second method the use of extraneous disintegrating material is dispensed with, the cells or organisms being disintegrated when in a frozen condition. In the apparatus exhibited the necessary cold and brittleness are secured by the use of liquid air.

Dr. Leonard Rogers exhibited five specimens of Hydrophidæ (poisonous sea snakes). These snakes swarm round the coasts of India and in other tropical seas, and cause some loss of life among fishermen. Their poison has recently been found to be more powerful than that of any other snakes.

Miss E. R. Saunders illustrated interesting cases of structural atavism resulting from cross-breeding. Experiments (Report Evolution Committee, 1902) with stocks suggested that when glabrous plants of dissimilar colours are crossed together, the offspring might be hoary. Actual trials have proved this to be true. When glabrous cream or white are crossed with each other, or with glabrous plants of other colours, the offspring are all hoary; but when colours other than white or cream are crossed together, the offspring are all glabrous.

Fossils in Cambrian quartzite were shown by Prof. J. Norman Collie, F.R.S. These fossils were found on the surface of a glacier in Desolation Valley (near Laggan Railway Station), Canadian Rocky Mountains.

Dr. Henry Woodward, F.R.S., exhibited two photographs of *Tetrabelodon* (*Mastodon*) *angustidens*, Cuvier, from the Miocene of Sansan, France, taken from the skeleton in the Museum of Natural History, Paris. This primitive form of Mastodon still retains two pairs of functional incisor teeth (tusks), one pair in the upper and one pair in the lower jaw, the upper ones being directed *downwards*. In modern elephants only one pair (the upper) incisors are present, and these are usually curved upwards. (See Dr. C. W. Andrews's paper, *Proc.* Roy. Soc., No. 474.)

The Royal Geographical Society had on view (1) hypso-

metrical and bathymetrical map of the Western Mediterranean and surrounding countries, curved to show the figure of the earth; (2) relief map of a part of the valley of the Semois in the neighbourhood of Rochepaut, Belgian Ardennes. These maps have been prepared under the direction of Prof. Elisée Reclus by Mr. E. Patesson. The map of the Mediterranean, in aluminium, is drawn on the scale of 1 : 5,000,000. It is curved to show the exact figure of the earth. Elevations of land and depths of water are shown by a system of contours and tinting. The second map is in copper, and represents the relief of the district without exaggeration of the vertical scale, and with the surface features carefully laid down. Both maps are intended for educational purposes.

Pictures shown by Mr. Arthur J. Evans, F.R.S., illustrated excavations at Knossos, in Crete, and included: (1) general plan of the palace, showing excavations to June, 1902, and general section, showing successive terrace levels, &c.; (2) photographic views; (3) coloured drawings of palace frescoes.

Other exhibits were chloroformed calf lymph; method of its preparation (from the Government Lymph Laboratories), Dr. Alan B. Green; development and variation of the colour-pattern in Mexican species of lizards (Cnemidophorus and Ameiva), Dr. H. Gadow, F.R.S.; (1) true (glandular) hermaphroditism in a domestic fowl; (2) microscopic sections of prehistoric human bone, and of a prehistoric human urinary calculus, Mr. S. G. Shattock. Mimicry in butterflies from British East Africa and Uganda, Mr. S. A. Neave; specimen of Trypanosoma found by Dr. Castellani in cerebro-spinal fluid from sleeping sickness patients (Uganda), Dr. Aldo Castellani; specimens of a remarkable radiolarian of complex structure, Dr. G. H. Fowler; restored models of extinct fishes, the Director, British Museum (Natural History); preparations illustrating the cell-phenomena met with in apogamy, Prof. J. B. Farmer, F.R.S., Mr. J. E. S. Moore, and Miss L. Digby (see p. 71); remains of pigmy elephant and pigmy hippopotamus obtained from caves in Cyprus, Miss Dorothy M. A. Bate (see p. 71); (1) photographs illustrating the late eruptions in St. Vincent and Martinique; (2) volcanic dusts, ashes, and other ejecta of the West Indian volcanoes, West Indies Volcanoes Committee of the Royal Society; micrographs of volcanic dust from Mount Soufrière, St. Vincent, eruption, May 8, 1902, Mr. Thomas Andrews, F.R.S.; (1) the experimental demonstration of the curvature of the earth's surface recorded by photography; (2) photograph of ship hull-down at sea, Mr. H. Yule Oldham.

During the evening lantern demonstrations were given by Sir Benjamin Baker, K.C.B., F.R.S., illustrative of the Nile Dam Works, and by Prof. Harold B. Dixon, F.R.S., on the analysis of explosion flames by photography. The latter demonstration included (1) photographs of explosion flames, taken on very rapidly moving films, showing the genesis of the explosion-wave as the flame travels from the point of ignition, and the influence of reflections from the ends of the tube; (2) photographs of sound-waves moving through the explosion-flame, by which the approximate temperature of the flame may be calculated.

COOPERATION IN ASTRONOMY.

THE suggestions contained in the subjoined extracts from a paper by Prof. E. C. Pickering on "The Endowment of Astronomical Research," recently issued from Harvard College Observatory, will, we hope, be taken up by one of the many generous benefactors of science and higher education in the United States. The fundamental idea is the organisation of the forces which exist for the advancement of knowledge of astronomy. Many gifts have been made to astronomy in the United States, but in some cases the results have been disappointing, because the donors have not consulted astronomers as to the best way to promote scientific advance.

Imposing observatories are useless without instruments, and fine telescopes and spectroscopes depend upon "the man at the eye end" for the return they will give for the expenditure upon them. To obtain the best results, the astronomer with original ideas and progressive spirit should be placed in a position where he can carry on his work to the best advantage, and instruments should be used by men who require them for the increase of knowledge. This is the object of the plan proposed by Prof. Pickering. Money, materials and men available for astronomical research are to be brought together so that each is used to the best advantage.

In the United States, where the liberal benefactor has endowed scientific work to an extent unparalleled in any other country, the scheme will probably be taken up. Though the gifts to higher education and research have been so many and generous in the past, Prof. Pickering remarks that owing to the industrial prosperity of America "gifts may be expected ten times as large as those of the last century, during which Harvard College Observatory received three funds exceeding one, two, and three hundred thousand dollars respectively." He has therefore considered how a gift of one or two million dollars, if given to Harvard for astronomical purposes, could be best expended. The cooperative scheme of work suggested is one which would certainly accelerate progress, and the results attained would be such that enlightened donors could see and appreciate them.

There would be no attempt to interfere with independent work; in fact, the scheme aims at promoting such work and providing for the publication of the results. The Carnegie Institution was established with the same objects, and has already provided the means for carrying on important inquiries in various branches of science. Prof. Pickering's plan is worthy of the broad views associated with Harvard College Observatory, and we trust that means will be forthcoming to carry it into effect. We reprint part of the circular in which the plan is put forward.

The following outline of a plan will show how a sum of fifty to one hundred thousand dollars annually could be advantageously expended for astronomy by this observatory. A board of advisers, consisting of several of the leading astronomers of the country, would be appointed which would meet once a year, or at first oftener, to consider how the available income could be best expended in order to receive the greatest scientific return.

This board would consist partly of the directors of observatories who could expend portions of the income themselves, and partly of older astronomers who, having retired from active work, could decide without prejudice how the income could be expended to the best advantage by others. They would have authority to add temporarily to their number astronomers who might be invited to participate in any special work, and who could thus take part in their discussions on equal terms. All expenses of this board would be paid from the income, and except for clerk hire these would be almost the only executive expenses. A circular letter would be sent to all astronomers, inviting application for aid and suggestions for methods of expending the income. If possible, close relations would be established with the trustees of all the research funds which could be used for astronomical purposes, to increase efficiency and avoid duplication of work. The most important duty of the board of advisers would be to consider each year what departments of astronomy were being neglected, and to secure the needed observations, or if necessary undertake them themselves, or see that they were made at Harvard. As every astronomer is inclined to undertake the work which attracts him most, especially interesting investigations are likely to be duplicated unnecessarily, while laborious or unattractive investigations are neglected. This is particularly objectionable, since in astronomy, a science of observation and not of experiment, an opportunity once missed can in many cases never be recovered. As an example of needless duplication, fifty observatories agreed to observe the planet Eros during its opposition in 1900, but, so far

as known, only two or three have made the reductions needed to render their observations of any value. When a plan was decided on, it would be discussed by the entire board, and it is obvious that their combined experience would render serious mistakes less probable than when all depends on the judgment of a single individual, as is now the case. They could find the best man for a given research, and give him the best possible facilities for carrying it on. They could undertake larger and more difficult researches than a single observatory could attempt. It would be the power of many, instead of one, and of large, instead of restricted, resources. The opportunity offered to such a board of advisers, having control of the principal instruments of the country and a large sum of money available to set at work any particular corps of astronomers, ought to secure results far beyond those attainable at any existing observatory. All the advantages of a trust would be secured, with none of its objections. No one could object to a trust in wheat, for example, if its only object was to increase the quality and quantity of the crop, and to furnish it to consumers at the lowest rates, also to aid those not members of the trust in every possible way. In the present case, these conditions would be enforced by a body of men entirely unprejudiced, the Corporation of Harvard College. It is universally admitted that in the industrial arts there is a great advantage in cooperation, and in carrying on work on a very large scale. The same remarks apply to scientific investigation, with the added advantage that the supply and demand are indefinitely great, so that the market can never be glutted.

Apart from the advantages to astronomy of such a plan as is here outlined, it is believed that it would serve as a valuable example to the other sciences, and the moral effect of promoting uniformity of purpose, and friendly aid to one another by astronomers of all countries, would encourage other donors. An incidental advantage of this plan is that it could be tried on a small scale, as for a single year, and the donor could thus see what results were likely to follow if he made the plan permanent.

Of course, every effort would be made to establish the closest relations with astronomers in general, as the object of the institution could not be attained if the work done was not regarded as advancing astronomical research in the best way. Much might be accomplished through existing societies and periodicals. Another matter of especial importance is that when an astronomer is aided who is qualified to carry on a work in the best way, no restrictions should be made on the appropriation which would in any way interfere with his obtaining the best results.

It will be noticed that this plan differs from those governing existing funds for research in being active and not passive. While the trustees of other funds wait for applications, and then consider what appropriations can be made, it would be the aim of the advisers of this fund to learn what astronomers desired aid, what instruments now unused were available for work, and what valuable material remained unpublished and consequently useless for lack of means. Its special object would be to determine the needs of astronomers, to find what subjects were being neglected, especially those the usefulness of which would be lost by delay, and, if possible, to take the necessary steps to secure their execution. Much might be done with existing funds, and it is believed that the trustees of such funds would, in many cases, welcome the means of expending the available income to the best advantage. The opportunities for good work are far in excess of the present means for supplying them. Even the great resources of the Carnegie Institution will be able to respond to only a portion of the excellent applications made to it for aid.

It is most important that unnecessary delays should be avoided. It often happens that an astronomer could undertake a piece of work at once, perhaps during a summer vacation, while after a delay of several months he might be unable to carry it out, or might have lost many of the details then fresh in his mind. This is still more important with large pieces of work. A delay of several years may render a mature astronomer incapable of completing a work, which if undertaken at once, he could carry out with his greatest vigour and skill.

These remarks apply with equal force to the present plan of work. The Harvard Observatory has now the appliances, both intellectual and physical, for undertaking large pieces of work. Several of the leading astronomers of the country are in sympathy with such a plan for cooperation, so that the important methods of organising and initiating a system could be devised at the present time under very favourable conditions which may not prevail a few years hence, although the plan once started could easily be carried on by others. It therefore seems wise to make a beginning, however small, hoping to show results that will lead to an early fulfilment of the entire plan.

The undersigned, therefore, invites the astronomers of this and other countries to send to him applications for aid. A brief statement of the case in form for publication should be made, generally not exceeding two hundred words in length, with an estimate of the cost, and any additional necessary details. If publication is not desired, it should be stated.

The undersigned will then use his best efforts to secure the execution of such of these plans as commend themselves to him, reserving the right to omit all others. If the list of applications received seems worthy of it, he will publish and distribute it to possible donors, and will endeavour to secure its publication elsewhere. He will also bring such applications as commend themselves to him to the attention of the officers in charge of the following research funds, with which he is officially connected:—

Rumford Fund of the American Academy. Principal, 52,000 dollars. Income available to aid American investigators in light and heat.

Elizabeth Thompson Science Fund. Principal, 26,000 dollars. Income available for investigators of all countries in all departments of science. Appropriations seldom exceed 300 dollars.

Henry Draper Fund of the National Academy. Principal, 6000 dollars. Accumulated income April 15, 1902, 1515·99 dollars. Available for investigations in astronomical physics, by citizens of the United States.

Advancement of Astronomical Science Fund of the Harvard College Observatory. Principal, 70,000 dollars, of which 10,000 dollars is now available as stated above. Income may be used for astronomers of any country.

When we consider the great sums at the disposal of the trustees of the Carnegie Institution, and the large unexpended balances of the various research funds of the National Academy, it is not probable that any really worthy investigation requiring only a few hundred dollars for its execution need fail for want of such a sum.

There is another direction in which the writer believes that a great astronomical return could be obtained for a reasonable expenditure of money, some of which is already available. There are, in the United States, many telescopes of large size, which are now in use during only a small portion of every clear night. It is believed that in many cases advanced students in astronomy would be glad to undertake systematic observations with such instruments for a salary equivalent to a fellowship. They would thus be enabled to continue their studies, and at the same time make valuable additions to our knowledge of astronomy.

Larger investigations may be carried on by the Carnegie Institution or by private gift. For such investigations the undersigned offers assistance to prospective donors, *if they desire it*. He will in that case secure for them the opinions of the leading astronomers of the country regarding any proposed investigation. A wealthy man, when making a large investment in an industrial enterprise with which he was not familiar, would always obtain the opinion of an expert, for which he would often pay a large sum. How much more important is it in a subject like astronomy, with which he is likely to be still less familiar, that he should learn the views, which would be given freely and without charge, of the principal experts in the country who have devoted their entire lives to the consideration of these subjects.

In brief, it is proposed to establish an institution in connection with the Harvard Observatory the aim of which should be to advance astronomy as much as possible by making appropriations under the combined advice of the leading astronomers of the country. Much attention would be paid to neglected subjects, especially to those which cannot be

provided for by later observations, to secure for persons properly qualified the use of powerful telescopes now idle and therefore useless, and, in general, to secure for the person best qualified for any given research the best possible means of carrying it on. It would provide means for co-operation, and would aim at the advancement of astronomy, regardless of country or any personal considerations. The cost of this plan, if fully carried out, would be less than that of a first-class observatory, and it could be fairly tried for a short time at a moderate expense. For success, it must be wholly unselfish and this condition permanently secured, the investments must be safe, and the net income large. It is believed that no guardian would more surely fulfil these conditions than the Corporation of Harvard College. EDWARD C. PICKERING.

THE ROYAL VISIT TO GLASGOW.

THE laying of the memorial stone of the new buildings for the Glasgow and West of Scotland Technical College by His Majesty King Edward on Thursday, May 14, is a gratifying indication of the importance now attached to an efficient system of technical education. The ceremony at the College was the first item on the programme of the Royal visit to the city, and, except as regards the weather, which was more lavish of the April shower than the May sunshine, was most successfully carried out. An hour before the arrival of the King and Queen upwards of 4000 guests had assembled on the site of the new buildings, and their Majesties, on stepping on to the royal platform, received a most loyal welcome. Lord Balfour of Burleigh, the minister in attendance on the King, introduced to His Majesty Mr. W. R. Copland, the chairman of the Governors of the College, and Mr. D. Barclay, the architect of the new buildings, and the laying of the memorial stone was immediately proceeded with. In thanking His Majesty, Mr. Copland recalled the fact that, so long ago as 1881, on the laying of the memorial stone of the Central Technical College of the City and Guilds of London, His Majesty was pleased to recognise the importance of educating persons destined to take part in the productive industries of the kingdom, and referred to the training of the intelligence of the industrial community as the great factor in retaining the position of Britain as a manufacturing nation. The King, in reply, expressed the great pleasure it had given him to lay the memorial stone; he had long recognised the importance of the work done by institutions of this kind, and hoped the building now to be erected would realise to the full the expectations of the governors.

In the course of the day their Majesties visited the University, the foundation stone of which they had laid on October 8, 1868. The Very Rev. R. H. Story, D.D., Principal and Vice-Chancellor of the University, the professors, lecturers and demonstrators, and a large body of graduates were assembled in front of the magnificent building on Gilmorehill, and in the name of the University the principal presented an address to His Majesty. In the address it was noted that, except on two occasions, in 1849 and in 1888, when Queen Victoria visited Glasgow, no Sovereign of Great Britain had seen this University since King James VI. visited it on his return to his ancient kingdom after succeeding to the throne of England. In his reply the King expressed his great gratification at having an opportunity, accompanied by the Queen, of renewing his acquaintance with the ancient University; he was deeply interested in the allusions to the visits of his predecessor King James VI. and of his august and beloved mother, Queen Victoria; he recalled with satisfaction his own share in laying the foundation stone of the noble building, and he earnestly desired that this and other universities as schools of higher learning might grow and prosper, and so advance the material progress of his people.

After His Majesty had replied to the address, the Deans of Faculties were presented to him by Lord Balfour.

The constitution under which the Glasgow and West of Scotland Technical College is now working dates from 1886, but the institution itself had its origin in Anderson's College, which was founded in 1796 under the will of John Anderson, M.A., F.R.S., professor of natural philosophy in the University of Glasgow, and is thus certainly the oldest institution of the kind in Great Britain, and probably in the world. Prof. Anderson was in many respects a remarkable man. The idiosyncrasies of his character brought him into frequent conflict with his colleagues in the University, but it is more pleasant to record that he seems to have been deeply impressed with the importance to the industries of the city of awakening in masters and workmen an intelligent interest in the scientific aspects of their trade. He made frequent visits to the local workshops, and took great pains to make himself familiar with local industries. It is well known that when James Watt had difficulties put in his way by the incorporation of hammermen of Glasgow he was appointed mathematical instrument maker to the University, and it was Anderson with whom he was most closely associated in this post. In furtherance of his aims Prof. Anderson inaugurated classes in the University designed to attract employers and workmen as well as the ordinary university students, and these he carried on until his death in 1796. At the present day, when technical education has assumed such a prominent position in the public mind, it is but fair to recall with gratitude the work of the man who may be justly named its pioneer.

On his death Prof. Anderson bequeathed all his means "to the public, for the good of mankind and the improvement of science, in an institution to be denominated 'Anderson's University.'" He directed that the management of the institution was to be vested in the Board of Trustees constituted under his will, and this Board continued in existence until 1886, when the institution was incorporated in the Glasgow and West of Scotland Technical College.

The first chair created was that of chemistry and natural philosophy, and was occupied by Dr. Thomas Garnett until 1799, when he was called to fill the first professorship in the Royal Institution. His successor in Glasgow was Dr. George Birkbeck, who formed a special class for "the gratuitous instruction of the operatives of Glasgow in mechanical and chemical philosophy," in the belief that "men should be taught the principles of the arts they practise." This class, which was named "the Mechanics' Class," separated in 1823 from Anderson's College and took the title of "Mechanics' Institution," the first of the many mechanics' institutions that marked the movement for the scientific education of artisans. In 1881 the Glasgow Mechanics' Institution changed its title to that of "The College of Science and Arts," and continued to maintain a separate existence until it was merged with the parent institution in the present Technical College.

The names of many eminent men are associated with Anderson's College. Among its professors were Dr. Andrew Ure, author of "The Dictionary of Arts and Manufactures"; Dr. Thomas Graham, afterwards Master of the Mint, for whom the honour is claimed of establishing the first laboratory for public instruction in chemistry in Great Britain; Dr. Thorpe, the present Director of the Government Laboratories; Dr. W. Dittmar; and Dr. G. Carey Foster, the present Principal of University College, London. Among its students were Dr. Livingstone; Lord Playfair; Dr. James Young, the founder of the Scottish oil industry; and Sir J. H. Gilbert, of Rothamsted. Lord Kelvin and his brother, Prof. James Thomson, were students of the Mechanics' Institution.

In 1886, by an Order of Her late Majesty, Queen Victoria, in Council, Anderson's College, the College of Science and Arts, the "Young" Chair of Technical Chemistry—founded

in connection with Anderson's College by its then president, Dr. James Young, referred to above—Allan Glen's Institution, and the Atkinson Institution were amalgamated to form the Glasgow and West of Scotland Technical College. The main object of the governors of the reconstituted institution has been from the first "to afford a suitable education to those who wished to qualify themselves for following an industrial profession or trade"; it is not the purpose of the College to supersede the ordinary apprenticeship, but rather to supplement it, and the courses for day students in engineering are arranged to permit of their spending the summer months in serving part of their apprenticeship, while devoting the winter months to college work.

The maintenance of the institution entails an annual expenditure of about 25,000*l.*, derived in approximately equal proportions from endowments, students' fees, Government grants, and grants from the Corporation of Glasgow and other public bodies.

The College work has hitherto been conducted in the buildings formerly occupied by the amalgamated institutions and in hired premises scattered over the centre of the city, but these have long been inadequate, and for some years it has been necessary to refuse admission to hundreds of students for lack of room. So serious is the want of accommodation that a gift of 5000*l.* by Mrs. John Elder to make provision for lectures of a popular character on descriptive astronomy cannot be utilised under existing conditions, and contemplated extensions in other directions are meanwhile impossible for similar reasons. In December, 1900, a meeting of the citizens was convened by the Lord Provost of Glasgow to consider the scheme which the Governors, after full deliberation on the various alternatives, had adopted for the erection of new buildings. A committee was formed to obtain subscriptions, and in less than two years a sum of nearly 180,000*l.* was raised.

The Governors appointed Mr. David Barclay, F.R.I.B.A., to be their architect, and they are satisfied that he has designed buildings admirably adapted to the purpose in view. They will consist of five large wings, two being parallel to George Street; the other three will be placed at right angles to them, and parallel to Montrose Street. The walls facing the streets will be of red Dumfriesshire stone; all the other exterior walls will be of white enamelled brick, thus securing a surface which will give the greatest amount of light to the rooms facing the three interior courts.

The following table indicates the main departments of the College, and, approximately, the space (in square feet) allotted to each:—mathematics, 5500; natural philosophy, 10,400; chemistry, 16,500; technical chemistry, 7500; mechanics, 10,000; machine design, 10,000; prime movers, 15,100; metallurgy, 4800; electrical engineering, 15,900; practical engineering, 4000; mining and geology, 3400; architecture and building construction, 7700; biology, 3200; industrial arts, 4000; workshops, 7900; bakery school, 2100; administration, library, general class-rooms, &c., 37,000.

The prime movers laboratory, the dynamo laboratory, and the practical engineering laboratory will be placed at the bottom of the interior courts, and will be lighted entirely from glass roofs. The chemical departments will occupy practically the whole of the top floor, and will contain several large laboratories and other similar rooms set apart for special purposes. The plan of confining each department to one floor has been followed throughout, with a view to promote efficiency in working.

The buildings will be the largest of the kind in Great Britain, and will cover nearly two acres; their cost, with the site, but exclusive of the equipment, will amount to about 210,000*l.* Meantime, contracts have been made for the erection of the first section of the buildings, comprising nearly three-fourths of the whole.

The inadequacy of the present buildings for the work of a technical institution has been long felt by teachers and students, but there are many scattered all over the world who have a grateful remembrance of the instruction and guidance they obtained in these old-fashioned rooms; there is every reason to hope that with improved facilities for work there will be quickened zeal to take advantage of them.

G. A. G.

NOTES.

WE are glad to know that steps have been taken to secure and erect a memorial of the late Sir George Stokes in Westminster Abbey. At a meeting of a joint committee of the University of Cambridge and the Royal Society, held on March 12, the Duke of Devonshire being in the chair, it was resolved that the authority of the Dean and Chapter of Westminster be requested to place a medallion relief portrait of Sir George Stokes in the Abbey of the same general character as the memorials of Darwin and other scientific men already there. A letter has since been received from the Dean of Westminster expressing his general assent to the proposal and his willingness to take detailed plans into consideration. Mr. Hamo Thornycroft, R.A., has undertaken to prepare a medallion, the material to be bronze, and the head to be in high relief. It is estimated that the cost of placing this memorial in Westminster Abbey will be about 400*l.*, and as there are doubtless many admirers of Stokes who would like to contribute to the fund being raised for the purpose of the memorial to him, a subscription list has been opened. The treasurers of the fund are the Vice-Chancellor of the University of Cambridge and the treasurer of the Royal Society. Subscriptions should be made payable to Messrs. Barclay and Co., Ltd., and should be sent either to them at their Cambridge branch or to the treasurer of the Royal Society.

THE two gold Hofmann medals, established in 1888 in connection with the seventieth birthday of August Wilhelm von Hofmann, for award to distinguished foreign men of science, have been conferred by the German Chemical Society upon Prof. Henri Moissan and Sir William Ramsay.

THE centenary of the announcement of the atomic theory by Dalton was celebrated at Manchester on Tuesday and Wednesday. We propose to publish an account of the celebration in our next number with an article upon the atomic theory.

THE Royal Society of Edinburgh will hold a conversazione in the rooms of the Royal Institution, Edinburgh, on Saturday, June 6.

AN International Exhibition will be opened at Athens on June 3, and will last six months. The British exhibits, as at present arranged, will occupy 500 square metres, and will consist mainly of engines, ship-models, and guns.

THE Central News Agency reports that, according to a despatch from the city of Mexico, the Colima volcano is again in active eruption.

DURING the week beginning June 1, Prof. J. J. Thomson, F.R.S., Cavendish professor of experimental physics in the University of Cambridge, will, says *Science*, give a course of lectures in the physical laboratory of the Johns Hopkins University on "A Theory of the Arc and Spark Discharges."

MR. W. L. SCLATER left England last week to resume his duties as director of the South African Museum at Cape Town. Before his departure he was presented with an address signed by nearly six hundred members of the Zoological Society, testifying to the tact and ability shown by him while occupying the post of secretary, to which he was provisionally elected.

A MARBLE bust of George Stephenson was unveiled at the railway station at Rome on April 23. The bust was presented by the Institution of Civil Engineers to the municipality of Rome as a supplement to the tablet placed in the vestibule of the railway station at Rome in 1881 to commemorate the centenary of the birth of the father of the railway system.

A general meeting of the British Academy was held on May 14, Lord Reay, the president, being in the chair. Papers were read by Dr. Edward Caird, Master of Balliol College, Oxford, on "Idealism and the Theory of Knowledge," and by Prof. W. M. Ramsay on "The Importance of a Systematic Exploration of Asia Minor (in conjunction with the recently formed societies for the same purpose in Austria and in Germany)."

We regret to record the death, on May 12, of Mr. William Talbot Aveline, at the age of eighty-one. He was engaged on the staff of the Geological Survey under De la Beche, as long ago as 1840. His early field-work was carried on in the region of the Mendip Hills and in South Wales; subsequently in many parts of North Wales, the western and midland counties of England, he personally surveyed large areas, while in later years he was called on to superintend the field-work in the Lake District. The maps and sections of the Geological Survey, especially in Silurian regions, form the chief records of his labours, for he wrote but little. He became a fellow of the Geological Society in 1848, and in 1894 he was awarded the Murchison medal in appreciation of his long-continued and careful labours in field-geology.

We learn from the *Athenaeum* that a Norwegian expedition, commanded by Captain Roald Amundsen, left Christiania a few days ago with the object of fixing the exact situation of the magnetic North Pole. The party are expected to be absent for four years, the route taken being by Lancaster Sound, Boothia Felix, where a magnetic observatory will be established for a period of two years under control of two members of the scientific staff, and back by the North-West Passage, Victoria Land, and the Behring Straits.

On Tuesday next, May 26, Prof. E. J. Garwood delivers the first of two lectures at the Royal Institution on "The Work of Ice as a Geological Agent"; on Thursday, May 28, Prof. J. A. Fleming commences a course of two lectures on "Electric Resonance and Wireless Telegraphy"; and on Saturday, May 30, Prof. S. P. Thompson begins a course of two lectures on "The 'De Magnete' and its Author." The Friday evening discourse on May 29 will be delivered by His Highness the Prince of Monaco on "The Progress of Oceanography," and on June 5 by Prof. H. H. Turner on "The New Star in Gemini." The extra discourse on June 19 will be delivered in French by Prof. Pierre Curie on "Radium."

A Paris correspondent states that on May 8, a balloon built for MM. Lebaudy made a notable performance. The balloon left the Moisson Aërodrome in the morning and returned to it after having navigated round Mantes at a distance of 10 kilometres. The performance was executed in 1h. 36m. by a circuitous way the length of which has been estimated as 37 kilometres. The length of the air-ship is 56 metres, and the volume 2300 cubic metres. The engine is a 40 horse-power. There were two persons on board, M. Juchmès, a well-known professional aëronaut, and a mechanician. The peculiarity of the balloon is that it has two screws working in the central part, and not a single propeller at some distance behind. There are two rudders behind at a distance of about 20 metres from the car, one for the vertical motion and the other for movement in a horizontal direction.

During the course of his speech at the opening of the Johnston Laboratories of the University College of Liverpool, of which a short account was given in these columns last week, the President of the Local Government Board made it clear that he at least understands fully the important part science has taken in the work of civilisation and progress. Mr. Long said that so long as he had the honour to occupy the position he now held he would do his best to secure on behalf of the Government of the day the utmost assistance that could be given to the advancement of science in all parts of the country. It seemed to him that the connection was very close between the development of science, and especially of that form of science which was known as preventive medicine, and the commerce for which this great country was so justly famous. There is no doubt of this intimate interdependence of scientific knowledge and commercial success, and Mr. Long did well to commend the people of Liverpool for having raised by donations to university education the sum of 200,000*l.*

At the anniversary meeting of the Royal Geographical Society on Monday, the medals and awards which are given annually for the encouragement of geographical science and discovery, and have already been announced (March 19, p. 469), were presented. In the course of an address the president said that Captain Sverdrup, in completing our knowledge of the Parry archipelago, had also completed our general knowledge of Arctic geography. The whole problem of Arctic geography had now been solved. There were many isolated pieces of work that would have to be undertaken, but none which would justify the dispatch of an expedition on a large scale. With regard to the Antarctic regions, he said that the German expedition had the great advantage of having selected one of the two best routes for Antarctic discovery. After giving a short summary of the position of the British expedition, the president said that the *Morning* must go south again next December, and for this purpose funds, amounting to perhaps 15,000*l.*, must be provided.

The fall of dust between February 21 and 23 last was observed over such an exceptionally extensive area of Europe, from Ireland eastward into Austria, that the phenomenon has attracted more than usual attention, and already a number of papers dealing with local falls have been written. On the May pilot chart, just published by the Meteorological Office, there is, however, an extremely interesting map of the area from the Equator to 55° N., and from 40° W. to 20° E., exhibiting at a glance the distribution of dust or sand, of mist, haze or fog, the mean barometric pressure for the five days February 18 to 22, and the wind direction recorded by observers out at sea. The accompanying letterpress shows that prior to the dust reaching Europe, sandstorms had interfered with the progress of the British Boundary Commission in Nigeria, south of the Sahara, and had also been experienced on the northern edge of the Sahara. At sea, off Africa, ships were hampered in their movements by the obscuration due to the great quantities of sand in the air, from the Gulf of Guinea to 30° W. and up to the Azores. The map shows very clearly that the wind about the Canaries, becoming easterly to south-easterly in direction on February 19, drove the dust-cloud to west and north-west, and near the Azores, the wind being south-westerly, the cloud was quickly carried north-eastward to England and Europe. It is deserving of notice that, according to the log of the R.M.S. *Briton*, keeping near the African coast, the sand was very dense, "huge quantities of red dust," with the wind at north-east, but a temporary change to south-south-west for ten minutes cleared the air immediately. On the wind going back into north-east, the sandstorm came over again. The steamer *Kirkby*, on the other hand, running westward from Madeira, had the dust fall with a south-east wind; when the wind changed to north the dust ceased.

A CORRESPONDENT of the *Times*, writing from St. Vincent on April 22, gives some interesting particulars of the Soufrière eruption of that date. Soon after daylight, he observed that inside of a quarter of an hour the enormous umbrella-like steam-cloud spread out enormously. At this time no noise was noticeable in the town. A little later, violent explosions occurred at frequent intervals. It soon became quite dark, but, following previous cases, everything began to go in the direction of Barbados. Fine metallic dust fell until next day, black and gritty, apparently magnetite. Châteaubelair did not suffer this time except for another deposit of sand and small stones. Georgetown suffered much, and large stones fell throughout the Carib country.

MUCH discussion has recently taken place with reference to the behaviour of the Weston galvanic cell as a standard of electromotive force. The observed anomalies appear to be dependent upon the behaviour of the particular concentration (14·3 per cent.) of the cadmium amalgam previously recommended for the standard form of the instrument, and are not connected with any change in the condition of the cadmium sulphate which enters into the composition of the cell. It seems to be now definitely established that with less concentrated cadmium amalgams the Weston element gives quite normal and trustworthy indications.

IN the *Sitzungsberichte der Berliner Akademie* Profs. Holborn and Austin describe some important experiments on the loss of weight of the platinum metals when heated to temperatures of 1000° to 1500° C. by means of an electric current. In the case of platinum, rhodium and iridium this loss of weight only takes place in an atmosphere containing oxygen, and is probably due to a chemical change. With palladium the phenomenon is independent of the nature of the surrounding gas, but depends very considerably on the pressure, the rate of loss of weight increasing as the pressure of the gas decreases. The behaviour of palladium agrees with the supposition that the loss of weight is simply due to sublimation.

WE have received from Dr. Jansen a short summary of the work already accomplished in the preparation of the "Technolexicon," to which we have referred on one or two occasions recently. Up to the present assistance has been received from 341 societies and more than 2000 industrial establishments and individuals. Of the societies, 272 are German, 42 English and American, and 27 French. An analysis of existing dictionaries, catalogues, &c., has given a list of something like one and a quarter million words, and it is expected that a large number more will be obtained from the note-books of collaborators, which will be called in during 1904. It is not expected that the dictionary will be ready for printing until the end of 1906.

PROF. LADISLAUS NATANSON has published in the *Journal of Physical Chemistry* for February a lecture delivered before the Cracow Academy of Sciences on "Inertia and Coercion." The author considers that the phenomena of nature can be divided into two classes, those which bear a character of permanence, and those which tend to subside. Under the first category he places the motions considered in the ideal systems of rational dynamics, and the equilibria of classical thermodynamics. There are, however, other cases in which the two classes of phenomena cannot be considered separately; these are studied in the subject of thermokinetics. Equilibrium is only a limit to phenomena, and to study what actually occurs in nature we must go on to study the laws which preside over their progress. In cases where a disturbance tends to subside, as in the diffusion of gases, the conduction of heat, and the flow of electricity, we find that the progress of the phenomenon is represented quantitatively by the flux of a certain quantity per unit time across unit surface. This flux depends in general on what may be called the stimulus of the phenomenon. This "stimulus" may give impetus to the flux, but it will in every case be largely employed in overcoming "coercion," a property which always tends to impede the flow, but does not in general (*e.g.* in the case of diffusion of gases) destroy it altogether.

IN the *Contemporary Review* for May, Mr. Frederick Soddy, whose name is well-known as a co-worker with Prof. E. Rutherford at the McGill University, Montreal, describes what may be referred to as the Canadian view of radioactivity. Briefly stated, this is to the effect that the radioactive thorium X, which is contained in ordinary thorium, and can be separated by precipitating the inactive thorium by means of ammonia, is a first decomposition-product of the unstable thorium atoms, that the radio-active emanations which are transmitted by thorium X to neutral gases, such as hydrogen and nitrogen, and which are condensed by cooling to $-130°$ C., represent a further stage in the atomic degradation, and finally it is suggested that helium —an invariable constituent of radio-active minerals—is possibly the last and stable product of the shattered thorium atoms. According to this view, which will not be received without an effort by chemists trained to believe in the conservation of matter and the immutability of the elements, the energy of radium is derived from the deflagration of a minute and unweighable proportion of the almost explosive radium atoms.

IN the *Nineteenth Century*, Mr. William Ackroyd, writing on "Radium and its Position in Nature," directs attention to the fact that radium not only has the highest atomic weight, but probably, in accordance with a well-known law, is also the rarest of the known elements. The close resemblance between Becquerel rays and X-rays is referred to, and it is suggested that the production of the former is analogous to the phosphorescence of calcium sulphide after exposure to sunlight. The possibility that an atomic bombardment may be the source of energy of radio-active bodies is, however, inferred from a reversed phenomenon observed by Prof. Graham Bell and Mr. Sumner Tainter, in which solids, liquids and gases are made to emit a musical sound under the influence of an intermittent beam of light pulsating 500 or 600 times in a second.

IN a paper dealing with the infection-powers of ascospores in the Erysiphaceæ (*Journal of Botany*, May), Mr. E. S. Salmon takes up a subject which has been almost untouched. It is known that conidial forms of apparently the same species are restricted in their power of germinating to definite and distinct host-plants, and thus there are differentiated a number of so-called biologic forms. Whether ascospores show a similar selective capacity for infecting host-plants is the problem which Mr. E. S. Salmon endeavours to elucidate.

AN article of considerable interest which appears in the *Transactions* of the Royal Scottish Arboricultural Society refers to the inception of the scheme for laying out tree plantations on the gathering grounds of waterworks. On the lands belonging to the Halifax Corporation, which took the lead in this matter, ash, sycamore and alder have been planted along with Scots pine and larch, but the intention is to leave the hardwood only as a permanent crop. Other papers which are of primary importance to foresters relate to the larch and its diseases, thinnings in planted spruce, and the injurious effect of smoke on trees.

THE study of ecological botany has not been so vigorously pursued during recent years in Great Britain as in other countries, but the few papers that have appeared have been the outcome of thoroughly sound work. A botanical survey of the West Riding of Yorkshire has been completed, and the results obtained by Dr. W. G. Smith and Mr. C. E. Moss for the south-western district are incorporated in an article published in the *Geographical Journal.* Both the descriptions and photographic illustrations are exceedingly good, but the main feature is the representation of the various formations on a map on the scale of two miles to the inch, which should be carefully studied by all ecological workers; also the origin and relationships of the types of vegetation are critically discussed.

No. 5 of the *Proceedings* of the Chester Society of Natural History contains a list of the species of Lepidoptera recorded from Chester and four adjacent counties, drawn up by Mr. G. O. Day, with the assistance of two other gentlemen.

WE have received vol. iv. of "El Peru," a work on the geology and mineralogy of that country published by the Geographical Society of Lima. It appears that by the decease of Dr. Antonio Raimondi in 1890, the publication of this work, which commenced in 1874, was interrupted. The present volume is based on that observer's manuscripts, which it has taken a long time to prepare for publication. The bulk of the volume is devoted to the rocks of the country, both igneous and sedimentary; but the latter part includes a series of miscellaneous observations, including the description of a lower jaw of *Mastodon andium* from a Peruvian locality. The work should be invaluable to Peruvian geologists and petrologists.

A VERY important and interesting contribution to the study of the venation of the wings of dragon-flies appears in No. 1331 of the *Proceedings* of the U.S. Nat. Museum, illustrated by no less than twenty-four plates and many text-figures. The author, Mr. J. G. Needham, treats the subject from a phylogenetic point of view, and claims to have discovered features in wing-development which will be applicable to insects generally, as well as others affecting the classification of dragon-flies. He finds, for example, that the same type of wing, in accordance with the needs of the mode of life, has been independently developed in totally different sections of the group. This, of course, largely affects the determination of fossil dragon-flies, which have been to a great extent named on the evidence of the wings, or portions of the same, and it is shown that in several instances these determinations are wholly incorrect. *Libellulium kaupi,* for instance, is probably not a dragon-fly at all, while *L. agrias* belongs to the Æschnidæ, the details of the specimen figured by Westwood being entirely different to those characteristic of the Libellulidæ.

VISITORS to the Natural History Museum will not fail to notice a great improvement in the appearance and instructiveness of the exhibits in the reptile and fish galleries, which were left at the death of Sir W. H. Flower in their original condition. Until the director undertook the rearrangement, the cases were crammed with a number of faded and "khaki"-coloured specimens, unaccompanied by any descriptive labels. The duplicate and superfluous specimens have now, for the most part, been weeded out, and those that are left placed so that they can be well seen by visitors. In many instances old specimens have either been replaced by new ones or have been painted up so as to give them, so far as possible, some sort of resemblance to the living animals; and this process of replacement and renovation is being actively continued. A large specimen of a thunny which has been for many years in the museum affords an excellent example of what can be done by judicious painting. The splendid colouring of the Malay python is displayed in a specimen presented by Mr. Rothschild, as well as by a second example, on which an artist was still engaged at the time when this was written. In the reptile gallery, which is in the more forward condition, descriptive labels have already been placed in several of the cases, in which the specimens have been removed from the old hideous sycamore stands and set on sanded ground-work.

THE fourth part of vol. lxxiii. of the *Zeitschrift für wissenschaftliche Zoologie* is entirely occupied by the first part of an exhaustive memoir on the structure of the cell, the author, Prof. E. Rohde, in this section devoting his attention to the nucleus and nucleolus. No less than nine beautifully coloured plates (some of which are double) illustrate this section of the subject. To the first part of the succeeding volume (lxxiv.) Herr E. H. Zietzschmann contributes an account of the morphology and histology of the scent-glands which occur on the face and limbs of different members of the deer family. Very full details are given of the nature of these structures in the greater number of the generic groups, and the existence of a small metatarsal gland in the elk is confirmed. It is perhaps a matter for regret that the author did not see his way to express any opinion as to the existence of an homology between the limb-glands of the deer and those of other ungulates. The scent-gland of the centipede *Iulus communis* forms the subject of an article by Dr. G. Rosse in the same fasciculus, which also contains papers on the spermatogenesis of Cœlenterata, and on the development of Dolomedes.

THAT our village ancestors were not devoid of artistic sense is apparent from many old articles of furniture that are bought up and treasured by the more wealthy classes. In a paper on the decorative arts of our forefathers as exemplified in a Southdown village in the *Reliquary* for April, Mr. W. Heneage Legge has given some interesting examples of beautiful objects still to be found in a single village, but the trend of modern ideas is to induce a dead monotony of machine-made shop goods. In the same journal Mr. F. W. Galpin gives an illustrated account of the Portland reeve staffs. These are notched quadrangular rods, by means of which the annually appointed reeve, or steward, keeps his account of the rents due to the King as Lord of the Manor.

MARRIAGE customs are generally interesting on account of the often rude symbolism that accompanies them; students of this branch of ethnology will find many marriage customs of various southern Indian tribes related by E. Thurston in *Bulletin* vol. iv., No. 3, of the Madras Government Museum. Ethnologists are fully aware of the value of the *Bulletins* of this museum, and the current number contains a mass of valuable material contributed by the energetic director of the museum. A short account of fire-walking in Ganjám does not record any new feature. Our schoolmasters are not likely to adopt any of the forty-two kinds of punishment inflicted on naughty boys in native schools.

WE have received the April number of the *Journal of Hygiene* (vol. iii. No. 2). Several papers deal with preventive medicine, *e.g.* the significance of the presence of the colon bacillus in ground waters, by Mr. Horton; the

distribution of the diphtheria bacillus in the throats of "contacts," by Dr. Graham Smith; and upon the correlation of several diseases of animals in South Africa, by Dr. Edington. Messrs. Graham Smith and Sanger discuss the biological or precipitin test for blood in its medico-legal aspects, and Messrs. Nuttall and Shipley complete their monograph upon the structure and biology of the Anopheles mosquito. The last is an important contribution, and is illustrated with some beautiful figures.

A SECOND, revised and enlarged, edition of Mr. H. M. Leaf's "The Internal Wiring of Buildings" has been published by Messrs. Archibald Constable and Co., Ltd. The new edition contains an additional chapter on electricity meters.

MR. EDWARD ARNOLD has published a revised edition of "A Course of Practical Chemistry," by Mr. W. A. Shenstone, F.R.S. This little book is intended as a laboratory companion for use with the author's "Inorganic Chemistry."

THE fourth volume of the "Petite Encyclopédie Scientifique du XX^e Siècle," viz., "La Chimie dans l'Industrie, dans la Vie et dans la Nature," by M. A. Perret, published by MM. Schleicher Frères and Co., of Paris, has reached a second edition.

WE have received a copy of "A Guide to the Early Christian and Byzantine Antiquities in the Department of British and Mediæval Antiquities," printed by order of the Trustees of the British Museum. The book runs to 116 pages, and is illustrated with fifteen plates and eighty-four wood-cuts. Visits to the Christian Room of the British Museum with this guide as a companion will, if the book has been previously studied, be full of interest. The guide, even without the visits, will prove of great value to teachers of history.

A SECOND edition of the "Life History Album," edited some years ago by Mr. Francis Galton, F.R.S., has been published by Messrs. Macmillan and Co., Ltd. The "Album" was, in its original form, the joint production of a small committee of medical men, but Mr. Galton has largely rearranged and rewritten the contents, so that the present volume may be regarded almost as a new publication. Convenient provision is made in numerous well-arranged tables for a record of the genealogy, description at birth, the life and medical history for each year from birth to a hundred years of age, and for records as to wife (or husband) and children. An appendix supplies tests of vision and nine charts on which to represent graphically the weight and stature for each year of life.

A SUPPLEMENTARY volume to the "Scientific Memoirs of Thomas Henry Huxley," edited by Sir Michael Foster and Prof. E. Ray Lankester, has been published by Messrs. Macmillan and Co., Ltd. In the preface to the new volume Prof. Lankester says, "when it was discovered that owing to a bibliographical obscurity we had omitted the later portions of Huxley's 'Survey Memoir' on fossil fishes from our collection, it became necessary to issue a supplement containing the important work which we had inadvertently passed over. The opportunity is taken to add three interesting essays by Huxley, which, . . . have considerable interest for zoologists." These essays are "Vestiges of the Natural History of Creation. Tenth Edition. London, 1853." "The Rede Lecture, 1883," and the "Inaugural Address. Fisheries Exhibition. London, 1883." The essays referred to are not contained in the published edition of Huxley's more general essays.

IN a recent number of the *Berichte* Carl Neuberg describes a method of resolving racemic aldehydes and ketones by means of an optically active hydrazine. The difference in solubility between the stereoisomeric hydrazones is very considerable, and on combining racemic arabinose with *l*-menthylhydrazine, it was found that the hydrazone of the lævorotatory *d*-arabinose readily crystallised out in colourless prisms, which were practically pure, whilst the hydrazone of the *l*-sugar remained in solution as syrup, which could not be crystallised.

THE wandering of a methyl group in the conversion of pinacone into pinacoline is a phenomenon that has long been familiar to chemists, and further illustrations have recently been given by Crossley in the case of the dimethyldihydroresorcins. Three further examples occurring in the antipyrin group of compounds are described by Knorr in the *Berichte*, and it is noteworthy that in every case the transference of the methyl radicle takes place from a $>C(CH_3)_2$ group. It would therefore appear that the reluctance of one carbon atom to carry two methyl groups is an important factor in bringing about this somewhat unusual type of change.

THE additions to the Zoological Society's Gardens during the past week include a Great Wallaroo (*Macropus robustus*) from South Australia, presented by Mr. T. Becket Birt; a Black-crested Eagle (*Lophaëtus occipitalis*) from West Africa, presented by Mr. A. Boyd; a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, a Schneider's Skink (*Eumeces schneideri*), five Common Skinks (*Scincus officinalis*), four Common Chameleons (*Chamaeleon vulgaris*) from North Africa, six Hispid Lizards (*Agama hispida*) from South Africa, a Naked-necked Iguana (*Iguana delictissima*) from Tropical America, two Seven-banded Snakes (*Tropidonotus septemvittatus*), a Mocassin Snake (*Tropidonotus fasciatus*), two Testaceous Snakes (*Zamenis flagelliformis*), a Hog-nosed Snake (*Heterodon platyrhinos*) from North America, four Gallot's Lizards (*Lacerta galloti*), four Atlantic Lizards (*Lacerta atlantica*) from the Canary Islands, deposited; a Cape Zorilla (*Ictonyx zorilla*) from South Africa, purchased.

OUR ASTRONOMICAL COLUMN.

NOVA GEMINORUM.—*Bulletin* No. 19 of the Yerkes Observatory is devoted to the observations of Nova Geminorum which have been made since the telegram announcing its discovery was received on March 27.

Prof. Hale records the colour of the Nova as "a strong red," and when in the best focus of the 40-inch telescope there is a decided crimson glow around the image for about 2" or 3", which is not present with the images of the comparison stars. Prof. Barnard found that with the 40-inch refractor the focus of the Nova did not differ appreciably from that of the surrounding stars.

Magnitude observations show a decrease from 8·51 on March 27·715 to 8·96 on April 4·583, with a secondary maximum of 8·76 intervening on March 30·673 (H.C.O. scale of magnitudes).

Two of the prisms of the Bruce spectroscope were removed and a special camera constructed on March 28, and the spectrum of the Nova photographed the same night with an exposure of 3h. 12m. In the spectrogram obtained Prof. Frost has found a band extending from about λ 4598 to λ 4696 (mean about λ 4647), and a very strong $H\beta$ line having its mean value at λ 4862, with two narrow bright maxima near the less refrangible end at about $\lambda\lambda$ 4877 and 4882. A less refrangible band extends from λ 5647 to λ 5685 (mean at λ 5666), and another from λ 5729 to λ 5775 (mean about λ 5752); a sharp boundary on the violet side of the latter suggests the presence of a dark band.

The kind of plate used is not very sensitive at about λ 5000, and this may account for the absence of the band λ 5016, which, however, is exceedingly faint in this Nova. Hγ is present, but scarcely strong enough to measure, and merges into a brighter band which extends from λ 4347 to λ 4371 (mean at λ 4359).

A reproduction of the spectrogram is given, and it is seen that the spectrum corresponds to those of Nova Aurigæ and Nova Persei at the later stages of their development.

A very faint bright band in the spectrum of Nova Geminorum in the region of the chief nebula lines is far too weak to measure.

PARALLAX OF THE BINARY SYSTEM δ EQUULEI.—Mr. W. J. Hussey publishes in *Bulletin* No. 32 of the Lick Observatory the results of his calculation of the parallax of δ Equulei, based on the micrometrical and spectroscopical measurements made at the Lick Observatory during the past three years. The method pursued is theoretically absolute, for in no way is the result dependent upon the assumption of values for comparison stars, as it is in the ordinary method of calculating parallax.

The formula used was published by Prof. A. A. Rambaut (*M.N.* March, 1890), and gives the absolute parallax of a system when the elements of the orbit, the relative velocity of the components in the line of sight, and the orbital velocity of the earth at the time are known.

The determination of the elements of the orbit made at Lick has led to the adoption of 5·7 years as the periodic time of revolution; using this value for the period, and taking the mean distance as 0″·28, the eccentricity as 0·46, the apastron and periastron distances as 0″·409 and 0″·151 respectively, the relative velocity in the line of sight, determined by the observers using the Mills spectrograph, as 20·5 miles per second, and the orbital velocity of the earth at the time as 18·2 miles per second, Mr. Hussey obtains

$$\pi = 0''\cdot071$$

as the parallax of this system, but states that this is probably not the final value, for the elements may be appreciably modified during the critical observations it is proposed to make during the next three years.

Taking this value for the parallax and the mean distance and period given above, the mass of the system becomes 1·89, the mass of the sun being taken as unity, and, as the components are not quite equal in magnitude, the brighter may have a mass equal to, but not greatly exceeding, that of the sun. The mean distance of the components is about four times that of the earth from the sun, but, owing to the great eccentricity of the orbit, the actual distance at periastron is just more than twice, and at apastron about five times, that unit. As the spectra of the components are both of the solar type, and as their masses are comparable with that of the sun, it might be reasonably assumed that their densities do not differ to any great extent from the density of that body.

A REGULATING OR RECORDING THERMOMETER.

A THERMOMETER which is capable of regulating the temperature of a room with considerable accuracy, or of keeping a continuous record of the temperature, is frequently required in laboratory work. Such a thermometer is described in the present article. Although there is little essentially new in its construction, the details on which success depends are the result of considerable practical experience, and as the manufacture of such an instrument should be within the powers of most laboratories employing a mechanic, it has been thought desirable to publish an account of it.

The estimation of temperature in this thermometer depends on the alteration in shape of a piece of flat brass tubing bent into spiral form and filled with a liquid possessing a large coefficient of expansion. If one end of the tube is fixed, the motion of the other end, magnified by a suitable arrangement of levers, serves as a measure of temperature. As the thermometer is intended for use within a range of temperature of at most three or four degrees, we are not concerned with the equality of the graduations per degree at different parts of the scale.

The illustration (Fig. 1) shows the general appearance of the thermometer arranged as a recording instrument. The brass tubing of which the spiral is formed has a section in the shape of a very flat ellipse, the longer diameter being ⅞ inch, the shorter 3/16 inch, while the thickness of the wall is 0·02 inch. The tube is bent into the spiral form by filling it with melted resin and bending it round a cylinder 8 inches in diameter, on which is cut a spiral groove. After the resin has been removed by heating the tube, brass plugs[1] are soldered into the ends, each plug having a central hole for the purpose of filling the tube with liquid. In the thermometer illustrated, these holes are shown closed by steel screws. A simpler and more efficient plan is to solder a short length of lead tubing into the brass plug. Then, when the thermometer has been filled with liquid, the end of the lead tube is pinched together and soldered. The spiral can thus be hermetically sealed without loss of liquid.

In order that the thermometer may acquire the temperature of the surrounding air as rapidly as possible, the surface is increased by soldering to the spiral a strip of thin sheet copper about four inches wide. The whole is painted dead black.

For filling the tube creosote has been found to answer well. The process of filling the tube is the most troublesome part of the work, as it is difficult to get rid of the air bubbles which cling to the interior. While it is being carried out the tube should be placed in melting ice.

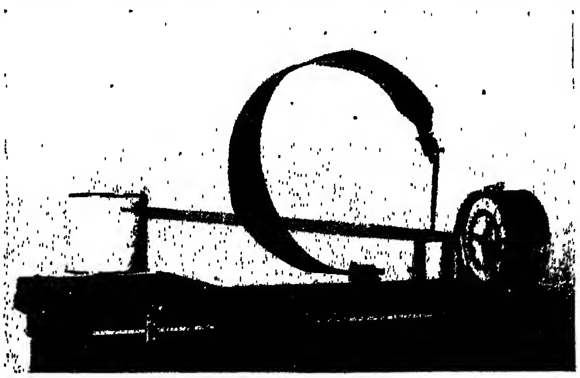


FIG. 1.—Recording Thermometer.

Funnels may be attached to the open ends of the spiral to facilitate the introduction of the liquid. When the tube is nearly full, liquid should be poured into either end in turn until the creosote rises in the other funnel free from air bubbles.

When the tube has been hermetically sealed, it is ready for attachment to the stand. Instead of fixing one end of the tube directly to the base board, it is fastened to one flap of a common brass hinge, the other end of which is screwed to the board. A hole is tapped in the upper flap and fitted with a screw the point of which bears against the lower flap, thus providing an adjustment for the distance between the two. This is a very simple method of giving a small alteration to the position of the fixed end of the spiral, and so adjusting the pen to any desired height on the recording cylinder.

The free end of the spiral is attached by a connecting rod of thin aluminium to a brass lever, half an inch in length, fixed to the spindle that carries the tracing arm. The length of the light arm which carries the pen is sixteen inches. Thus the actual motion of the end of the spiral is multiplied by the factor 32 at the recording drum.

The bracket carrying the spindle is formed of two uprights of thin sheet brass, screwed and soldered to a thicker base plate. The spindle itself is made of steel wire about three-sixteenths of an inch in diameter; the ends forming the pivots are turned down to a somewhat smaller diameter and ground into holes bored in the uprights. On the outer side of each upright is screwed a short length of flat steel

[1] The plugs should be of drawn brass, as it is found that creosote gradually percolates through cast brass.

spring, which bears against the projecting point of the spindle and so controls any lateral movement.

In addition to the recording cylinder a second clock will be noticed in the illustration. This was introduced because it was found that the pen was inclined to stick to the paper, so that the full range of temperature was not recorded. The clock once in every minute draws the pen away from the paper, so that it is free to take up its natural position. Hence the trace is made up of a series of dots instead of being a continuous line. The minute hand of the clock is replaced by a wheel in which sixty teeth are cut. Every minute one of the teeth engages with a short pin supported by a flat steel spring. When this pin is pushed aside it draws after it one of the springs referred to above as pressing against the point of the spindle. The spring at the opposite end of the spindle consequently comes into play and pushes the spindle in the direction of its length, thus relieving the pen from the paper.

In this thermometer the motion of the pen for a change in temperature of one degree Fahrenheit is about one inch (4·5 cm. per degree C.) at ordinary temperatures.

The thermometer selected for description is adapted for securing a continuous record of temperature. When it is desired to use such a thermometer to regulate the temperature, the pen may be replaced by a platinum point which is arranged to complete an electric circuit by contact with a platinum terminal or by dipping into a mercury cup. The current so set up may be used to operate a relay, and so switch on a stronger current, if heating by electricity is employed, or it may actuate some suitable mechanical arrangement for regulating the supply of gas to a stove. When it is necessary to maintain a uniform temperature for days or weeks together, it is most important that the sparking which takes place at the contact should be as far as possible reduced, otherwise the surfaces may become so contaminated that contact is uncertain, or in the case of platinum contacts may fuse together so that the contact is never broken. These are difficulties which those who have worked with such arrangements will appreciate. To overcome them it is well to reduce the current through the contact to the smallest possible value, and to place in parallel with the electromagnet which will form part of the circuit a non-inductive resistance. This resistance may be kept comparatively small, even at the expense of a somewhat larger current. A condenser inserted between the points of contact may be of service, but is not so effective as the plan mentioned.

It may be of interest to give some account of the success which has attended the use of these methods of regulating temperature in connection with the Blythswood dividing engine. The engine is placed in a detached building in a room fifteen feet long, ten feet wide, and ten feet high. Local conditions render it impossible to make use of a cellar. The room has double windows and shutters; it is warmed by two gas stoves, of which one is controlled by the regulating thermometer. During the greater part of the year this room can be kept at a temperature of 60° F., the variation in temperature being not more than one degree.

The controlling thermometer in this instance actuates, by an electromagnetic release, clockwork which supplies the necessary power for turning the gas on or off.

The dividing engine is enclosed in a wooden case inside this room. Originally the interior of the case was heated by electricity under the control of a regulating thermometer. The variations in temperature that were introduced by this method were sufficient to produce disastrous results in cutting a diffraction grating. Accordingly the case was surrounded with a lining of six inches of wool, and all the arrangements for securing a uniform temperature were made in the room outside. When this was done it was found that the temperature inside the case fell slowly but continuously. This was shown to be due to leakage of heat through the stand of the machine, which rested on a large stone block. To prevent this a space was cleared round the bottom of the stand, and this space was kept at a uniform temperature by electrical heating. This precaution was found to be effective, and the temperature of the case can now be kept constant with very considerable accuracy, the variation in four or five days not amounting to more than two-tenths of a degree Fahrenheit.

H. S. ALLEN.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Public Orator, Dr. Sandys, spoke as follows on May 14, in presenting Mr. Robert Bell, LL.D., F.R.S., Director of the Geological Survey in Canada, for the degree of Doctor in Science *honoris causa*:

Magnum profecto est provinciae maximae penitus explorandae et scientiarum terminus latius proferendis vitam suam totam dedicasse. Salutamus virum, qui per annos plus quam quadraginta provinciae maximae Canadensis flumina, lacus, montes, campos denique latissime patentes exploravit; ibi locis plurimis nomina primus imposuit, et, ipse mortalium modestissimus, flumini a se primum indagato suum nomen ab aliis inditum audivit. Atqui nomen suum non in aqua scriptum, sed provinciae tantae in saxis potius insculptum reliquit; regionis illius immensae geologiam, geographiam, biologiam, archaeologiam libellorum in serie longa illustravit, et non modo provinciae ipsius terminos ubique definivit, sed etiam scientiarum fines ubique propagavit.

Duco ad vos Reginae Universitatis Canadensis doctorem, Societatis Regiae Londinensis socium, provinciae Canadensis exploratorem indefessum, ROBERTUM BELL.

A university lectureship in mathematics, stipend 50*l*. a year, is vacant by the election of Prof. Larmor to the Lucasian chair. Candidates are to send their names to the Vice-Chancellor by June 3, with statements of the branches of mathematics on which they are prepared to lecture.

In a report on the administration of the engineering laboratory it is proposed that two readerships, one in mechanical engineering and one in electrical engineering, should be established for Mr. Peace and Mr. Lamb, the present demonstrators; that two new university demonstrators should also be appointed, and that, in addition to their stipends, each of these should receive certain payments from the fees of students receiving instruction in the department. The growth of the latter under Prof. Ewing's direction may be gathered from the fact that in 1892 the number of students was 39, and the fees 546*l*., while in 1902 there were 211 students, who paid 5005*l*. in fees. In the present year there are twelve teachers, in addition to the professor and the two demonstrators, engaged in the work.

The syndicate report that the new building for the medical school is almost completed, and that the last stone of the Humphry Museum has been laid. A sum of 8062*l*. is required for fittings, furniture, electric lighting, and heating appliances.

The discussion in the Senate on the proposed reestablishment of the professorship of surgery turned chiefly on the question whether or not full residence should be required of the professor. If non-residence were permitted, a smaller stipend might suffice, and the field of choice might be widened. Prof. Liveing, Prof. Woodhead and others urged strongly that the professor's usefulness would depend on his being resident in the University.

MR. EDWIN EDSER has been appointed head of the physical department of the Goldsmiths' Institute, New Cross.

A CONVERSAZIONE of the Parents' National Educational Union will be held at the Kensington Town Hall on Monday, June 8. The Countess of Aberdeen will preside, and a paper will be contributed by Miss Mason, founder of the Union.

THE Court of Governors of University College, Sheffield, has adopted resolutions to the effect that in the interests of higher education in the city and district it is essential that Sheffield College shall have the powers and *status* of a university similar to those granted to Birmingham, Liverpool, and Manchester, and also that application be made to the Privy Council for a charter.

THE Secretary of State for India has appointed a small committee to inquire and report to him on the question of the expediency of maintaining the Engineering College at Coopers Hill, as a Government institution for the supply of officers to the Public Works Department in India. The committee will be composed as follows:—Sir Charles Crosthwaite, Sir James Mackay, G.C.M.G., Sir William Arrol,

M.P., Sir Arthur Rücker, and Sir Thomas Higham, K.C.I.E., with Mr. J. E. Ferard, of the India Office, as secretary.

THE new science rooms of the Colston's Girls' School, Bristol, were opened on Friday last, May 15, by the Right Hon. Henry Hobhouse, M.P. The new building comprises three rooms, about 30 feet by 26 feet, and one smaller. The lecture room will be largely used for the study of botany, and is provided with a small conservatory, or window box, in which experiments, such as those showing the process of germination, will be carried out. In the chemistry laboratory benches are provided at which girls will work in sets of two, and each set will have a balance on side benches close at hand. The physics laboratory is on very much the same plan as the chemistry room. Mr. Hobhouse, in the course of his speech, remarked that the education of girls was of the highest importance, not only in order to fit them for their domestic duties, but also to provide good women teachers. Prof. Armstrong hailed the opening of the new science rooms as a proof that science, once almost neglected, was now considered a necessary part of a liberal education.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 26.—"On the Cytology of Apogamy and Apospory. (1) Preliminary Note on Apogamy." By J. B. **Farmer**, F.R.S., J. E. S. **Moore**, and Miss L. **Digby**.

The phenomenon of apogamy is exhibited when the young fern-plant springs directly from the tissue cells of the prothallium generation, instead of arising as the result of segmentation of the egg within the archegonium. It has been regarded as a "short cut" in the life-cycle, and some theoretical importance has been attached to it in connection

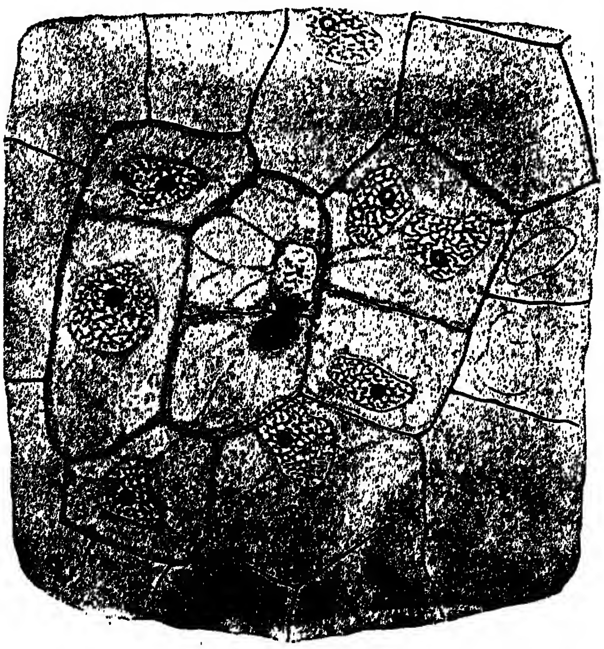


FIG. 1.—Group of prothallial cells with migrating nuclei.

with the relationships believed to exist between the gametophyte and the sporophyte, that is, between the prothallium and the fern-plant. Now it has been known for some years that the nuclei of these two generations exhibit a constant difference *inter se* of such a nature that each sporophyte nucleus contains twice as many chromosomes as do the individual nuclei of the gametophyte.

Evidence is brought forward to show that this nuclear change is brought about, in the apogamous development, by the migration of a nucleus to an adjacent cell, and its subsequent fusion with the nucleus of that cell. A considerable number of instances were observed in which single cells contained two nuclei, and when this was the case, one of the contiguous cells was always seen to be destitute of a nucleus. Instances of the transit of the nuclei through the walls were also seen. Further, the nuclei of some of the cells in the region where these occurrences were discoverable could occasionally be met with in stages at which it was found possible to estimate the number of chromosomes. In such cases these were double the number of those of the ordinary prothallial nuclei.

These facts lead to the inference that we are dealing with an irregular kind of fertilisation, or, at any rate, with a mechanism for doubling the nuclear chromosomes that is practically identical with what is seen in normal fertilisation. In the latter case the double number is arrived at by the addition of the chromosomes of the sperm-nucleus to those of the nucleus of the egg.

The annexed figure illustrates (1) two cells in which the nucleus of the one is passing through the parti-wall, and apparently fusing directly with the other nucleus; (2) a cell with two nuclei, one of which has been derived from the cell at the top right-hand corner of the figure.

May 7.—"Preliminary Note on the Discovery of a Pigmy Elephant in the Pleistocene of Cyprus." By Dorothy M. A. **Bate**. Communicated by Henry Woodward, LL.D., F.R.S., F.G.S., V.P.Z.S., late Keeper of Geology, British Museum, Natural History.

The elephant described was discovered by the author in 1902 during a search for bone-caves in the Kerynia Range in the north of the island. The collection obtained chiefly consists of a series of teeth, all procured from a single deposit, which also contained a very much larger quantity of the remains of *Hippopotamus minutus*.

The teeth of the Cypriote elephant are considerably smaller than those of *Elephas mnaidriensis*, the largest of the Maltese forms, and are also slightly inferior in size to those of *E. melitensis*. As a general feature it may be said that the molars from Cyprus are more simply constructed than those of the last-mentioned species, showing a slighter tendency to "crimping" in the enamel and in being less inclined to develop the mesial expansion of the plates of dentine so characteristic of those of *E. africanus*. Taking into consideration the several characters in which the teeth of the Cyprus form differ from those of all hitherto described dwarf species (putting on one side *E. lamarmorae*, the teeth of which are unknown to science), as well as the distinct habitat of the animal, it is believed to be specifically distinct, and it is therefore proposed to name it *Elephas cypriotes*. The discovery of this pigmy species is interesting in comparison with those from Malta and Sicily, and the occurrence of these different, though apparently closely related, small races of elephants in widely separated islands of the Mediterranean lends probability to the theory that this is a case of independent development along similar lines, the result of similar conditions of existence.

Physical Society, May 8.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—Mr. T. H. **Blakesley** exhibited and described a spectroscope of direct vision, of one kind of glass, and of minimum deviation for every ray that comes into the centre of the field of view. The refracting angles are such that the cosines of half the refracting angles are equal to half the index of refraction for the ray which is to have no deviation. The first prism is right-angled, and has one angle equal to the refracting angle calculated by the above rule. The second prism and the third possess the refracting angle so obtained, and the fourth is similar to the first. The plan adopted can be extended by employing more than one of the arrangements described, in sequence.—Prof. J. D. **Everett** read a paper on the mathematics of bees' cells.—Mr. W. A. **Price** read a note on the coloured map problem. He referred to the fact that only four colours are required to colour a map on the surface of a simply connected region, such as a sphere, in such a way that two countries marching on a boundary line are coloured differently, and exhibited two models of anchor rings the surfaces of which were divided in each case into six sections, each of which marched with

the other five; and a model of a ring having a cross-bar or stud, the surface of which was divided into eight sections, each of which marched with the other seven. In the case of maps on such surfaces, at least six and eight colours would be required in the respective cases.—Dr. **Watson** read a note on the construction and attachment of galvanometer mirrors. It has often been pointed out, notably by Lord Rayleigh and Prof. Threlfall, that it is better to increase the sensitiveness of galvanometers and similar instruments by improving the optical system, rather than by pushing the electrical sensitiveness to extreme limits. When working with ordinary silver on glass mirrors difficulties arise in connection with the attachment of the fibre and the fact that it is necessary to use a varnish, which in all cases produces distortion. These difficulties have been overcome by using quartz instead of glass, and platinum instead of silver.

Mathematical Society, May 14.—Prof. H. Lamb, president, in the chair.—Lieut.-Colonel A. **Cunningham** announced the discovery of seven new factors of Fermat's numbers (2^{2^n}), viz. when n is 9, the factor $2^{16}.37+1$; when n is 11, the factors $2^{13}.3.13+1$ and $2^{13}.7.17+1$; when n is 12, the factors $2^{16}.397+1$ and $2^{16}.7.139+1$; when n is 18, the factor $2^{20}.13+1$; when n is 38, the factor $2^{41}.3+1$. In the cases of 9, 12, 18, the factors were discovered by Mr. A. E. Western; in the case of 11, by Lieut.-Colonel Cunningham; in the case of 38, jointly by collaboration of these authors with Rev. J. Cullen.—Dr. H. F. **Baker** communicated a series of notes:—(1) On the definiteness of quadratic forms with imaginary coefficients; (2) On a certain form of logical argument which occurs in the proofs of several fundamental theorems of pure mathematics; (3) On the summation of Neumann's series representing a potential determined by boundary values; (4) On the formation of the variant equation in the theory of differential equations; (5) On some points in the theory of continuous groups.—The following papers were communicated:—Mrs. **Young**, The surface representing all right-angled spherical triangles.—Mr. W. H. **Bussey**, Generational relations defining an abstract simple group of order 32736.—Mr. W. H. **Young**, (1) On skew surfaces contained in a linear congruence; (2) On closed sets of points and Cantor's numbers. In the last of these papers methods and results obtained by the author in a previous paper on the theory of sets of intervals are applied to the theory of linear sets of points. The theory of the higher transfinite numbers is avoided, but the transition to these numbers is shown to arise naturally, and a short account is given of the most recent work on this subject.

NEW SOUTH WALES.

Linnean Society, March 25.—Mr. J. H. Maiden, president, in the chair.—The president delivered the annual address, which was devoted chiefly to the consideration of the principles of botanical nomenclature.—The newly-elected president, Dr. T. Storie Dixson, then took the chair, and the following papers were read:—A monograph of the Australian Membracidæ, by Dr. F. W. **Goding**. In studying this group, twelve genera, represented by thirty-five species, have been recognised.—Revision of Australian Lepidoptera, by Dr. A. Jefferis **Turner**. Under the above heading the author hopes to publish a series of papers dealing with the different families as time and opportunity permit. This first instalment treats of the Notodontidæ and Hyponomeutidæ.

DIARY OF SOCIETIES.

THURSDAY, MAY 21.

ROYAL INSTITUTION, at 5.—Proteid-Digestion in Plants: Prof. S. H. Vines, F.R.S.

INSTITUTION OF MINING AND METALLURGY, at 8.—Diamond Drilling in West Africa: J. N. Justice.—On the Occurrence of Mica in Brazil, and on its Preparation for the Market: H. Kilburn Scott.—Analytical Work in Connection with the Cyanide Process: J. E. Clennell.—Notes on the Treatment of Gold Slimes in Venezuela: Leslie Symonds.—Notes on Cupriferous Cyanide Solutions: H. A. Barker.—Notes on Chorolque Tin Mines and Alluvial Deposits, Bolivia: M. Roberts.

FRIDAY, MAY 22.

ROYAL INSTITUTION, at 9.—Dictionaries: Dr. J. A. H. Murray.

PHYSICAL SOCIETY, at 5.—Exhibition of Nernst Lamps, showing their Development from the Experimental Form up to the most Recent Types: J. Stöttner.—Exhibition of a Diagram of Single-piece Lenses: T. H. Blakesley.—On an Instrument for Measuring the Lateral Contraction of Tie-Bars, and on the Determination of Poisson's Ratio: J. Morrow.

MONDAY, MAY 25.

LINNEAN SOCIETY, at 3.—Anniversary Meeting.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—(1) Neatsfoot Oil; (2) The Nitric Acid Test for Cotton Seed Oil: J. H. Coste and E. T. Shelbourn.

TUESDAY, MAY 26.

ROYAL INSTITUTION, at 5.—The Work of Ice as a Geological Agent: Prof. E. J. Garwood.

ZOOLOGICAL SOCIETY, at 8.30.—On the present State of Knowledge as to the Inheritance of Colour in Fancy Rats and Mice: W. Bateson, F.R.S.—List of the Batrachians and Reptiles collected by M. A. Robert at Chapadá, Matto Grosso (Percy Sladen Expedition to Central Brazil): G. A. Boulenger, F.R.S.—Note on some Bulimulidæ from Matto Grosso (Percy Sladen Expedition to Central Brazil): Edgar A. Smith.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Etiology of Leprosy: Jonathan Hutchinson, F.R.S.

WEDNESDAY, MAY 27.

GEOLOGICAL SOCIETY, at 8.—An Experiment in Mountain-Building: Lord Avebury, P.C., F.R.S.—(1) The Toarcian of Bredon Hill, and a Comparison with Deposits Elsewhere; (2) Two Toarcian Ammonites: Sydney S. Buckman.

THURSDAY, MAY 28.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—On the Bending of Waves round a Spherical Obstacle: Lord Rayleigh, O.M., F.R.S.—Sur la Diffraction des Ondes Électriques a propos d'un Article de M. Macdonald: Prof. H. Poincaré, For.Mem.R.S.—An Analysis of the Results from the Kew Magnetographs on Quiet Days during the Eleven Years 1890–1900, with a Discussion of Certain Phenomena in the Absolute Observations: Dr. C. Chree, F.R.S.—On the Theory of Refraction in Gases: G. W. Walker.—Researches on Tetanus: Prof. Hans Meyer and Dr. F. Ransom.—The Hydrolysis of Fats in vitro by Means of Steapsin: Dr. J. Lewkowitsch and Dr. J. J. R. Macleod.

ROYAL INSTITUTION, at 5.—Electric Resonance and Wireless Telegraphy: Prof. J. A. Fleming, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.—Annual General Meeting.

FRIDAY, MAY 29.

ROYAL INSTITUTION, at 9.—The Progress of Oceanography: Prince of Monaco.

SATURDAY, MAY 30.

ROYAL INSTITUTION, at 3.—The "De Magnete" and its Author: Prof. S. P. Thompson, F.R.S.

CONTENTS. PAGE

THURSDAY, MAY 28, 1903.

THE ERUPTIONS OF MONT PELÉE.

Mont Pelée and the Tragedy of Martinique. By Angelo Heilprin. Pp. xiii + 335. (Philadelphia and London: J. B. Lippincott Company.) Price 15*s.* net.

THERE have been not a few greater catastrophes than that in which the city of St. Pierre was annihilated, and all its inhabitants (with only one or two exceptions) killed in a few minutes, but the peculiar circumstances of that tragedy have combined to bestow on it a great amount of interest. The city was one of the fairest in the western hemisphere, and no less famous for its profligacy than for its beauty. The suddenness with which it was destroyed, the awful circumstances with which this was attended, and the strange and almost unprecedented nature of the calamity have all combined to lend it a peculiar horror. At first the newspapers were filled with lurid and incoherent accounts of what had taken place, and all manner of exaggerations regarding the condition of Martinique were mingled with the most gloomy forebodings regarding the future of the island. In course of time a more rational spirit prevailed, but it is perhaps even yet too soon to expect a calm and entirely scientific study of all the remarkable features of the catastrophe.

Meanwhile the facts are being carefully sifted by various scientific men, and to the brief reports already published by Prof. R. T. Hill, Mr. E. O. Hovey, and the Commissioners of the French Academy of Science, this most interesting volume by Prof. Heilprin is a very welcome addition. In many ways the author of this book combines the qualifications necessary for successful treatment of the subject. He is an eminent naturalist, a much travelled geographer, and to his scientific knowledge he adds a dauntless courage which has enabled him to face calmly all the dangers of the dreaded volcano of Martinique. The book, moreover, is written in a style so graphic and vigorous that the reader is carried along in breathless interest, and no one who can enjoy a thrilling tale of adventure, however little he may be interested in scientific theories about volcanoes, could possibly put it down until he had reached the concluding page. The photographic illustrations are excellent. Many of them have been taken from Prof. Heilprin's negatives; others are from other sources, and have already appeared in the newspapers.

To those who have followed carefully the history of the eruptions, there is a great deal in the book that is not new. Much of it has appeared already in magazine articles by Prof. Heilprin and other writers, but even when following a well-worn path, the author is never dull, and his *résumé* of the earlier accounts is valuable, if only because he was one of the first scientific men to reach the island after the tragedy, and had in consequence special facilities for sifting the evidence before that rank growth of misstatement and exaggeration, which rapidly sprang up, had time to reach its full development. This, however, is merely the prelude to his tale, and the interest deepens when he describes the efforts he made to obtain a view of the crater near the summit of the mountain, and to study the processes at work there. He was the first to reach the actual summit after the tragedy of May, 1902, but luck was against him, and the mountain was veiled in mist; next day he returned, but still was unable to make out the details of the interior of the crater. In this he was not more unfortunate than other observers; we met a newspaper correspondent in Fort de France last year who had been five times on the top of Montagne Pelée, and had failed to secure a single photograph that would bear reproduction. As a matter of fact, those who would learn the condition of the crater should refer to the descriptions by Mr. Hovey and Prof. Lacroix, whose accounts are much clearer than those given in the book before us.

Though baffled, he was not defeated, and in the month of August Prof. Heilprin returned to Martinique to renew his investigations. He again ascended the mountain from its eastern base, and this time it is clear that he had a very narrow escape with his life. The volcano was very active, and was emitting a vast cloud of dust and casting great bombs for hundreds of yards from the crater. The descriptions of the scenes on the upper part of the volcanic cone are vivid, and to those who know with what suddenness the deadly black cloud can rise from the crater and sweep down the mountain slopes to the sea, it is evident that the party carried their lives in their hands. Not much information of scientific value was likely to be obtained in the circumstances, for it was impossible to approach sufficiently near the crater to see what was going on there. Prof. Lacroix has subsequently ascertained that what was at first regarded as an interior cone of ash is really a solid pillar of lava rising up from the bottom of the crater until it overtops the former summit of the mountain. The lava of Montagne Pelée, in fact, is so viscous and so nearly consolidated that it is being forced out as ice or lead can be forced through a narrow orifice under great pressure. So long as it is in its present condition it cannot possibly flow over the ground, and when the steam within it expands the mass is in large part shivered into dust.

The second fatal eruption of Pelée, that in which the village of Morne Rouge was destroyed and 2000 lives were lost, took place when Prof. Heilprin was residing on the mountain. His narrative of the events is wonderfully graphic, and though the fatal cloud was discharged at night, and in the darkness it was not possible to see exactly what happened, it is quite certain that the eruption was of the same type as that in which St. Pierre was levelled with the ground. Next day Prof. Heilprin visited the scene of the disaster and interviewed the survivors. Their experiences seem to have been very similar to those of the inhabitants of the Carib country of St. Vincent during the great eruption of May 7. The chapters of this book in which the story of this eruption is recorded are a very valuable contribution to the scientific history of the activity of Montagne Pelée.

The concluding chapter, in which the phenomena of the eruption are discussed, is in some ways not the least interesting in the book. From it we learn that

the author has discarded his bizarre hypothesis that the black cloud consists of "carbon gases" produced by the distillation of beds of asphalt in Tertiary deposits beneath the volcano. He is now of the same opinion as other scientific men, viz., that the main constituents of the cloud were steam, hot dust and sulphurous acid. We can hardly pass without remark his extraordinary calculations of the amount of dust ejected by Montagne Pelée during the latter part of 1902. He arrives at the conclusion that 480 millions of cubic feet of solid sediment have been discharged every hour, and is inclined to believe that this is an under-estimate. So far at least as regards that period when we were in Martinique in July, this is a wild exaggeration. For hours at a time the volcano emitted hardly a puff of steam; a casual visitor might never have suspected that the deep gully near the summit led into the crater; the amount of dust discharged was negligible. Yet this was the period immediately preceding and immediately following the eruption of July 9, which was one of the most important eruptions of last summer. When Prof. Heilprin adds, "We ask ourselves the questions—What becomes of the void that is formed in the interior? What form of new catastrophe does it invite?" we seem to hear the echo of the dire predictions which resounded in the colonial journals about twelve months ago.

JOHN S. FLETT.

EXPERIMENTS ON ANIMALS.

Experiments on Animals. By Stephen Paget. Pp. xvi+387. New and revised edition. (London: Murray, 1903.) Price 6s.

A BOOK which reaches a second edition in two years can do so only in response to some distinct demand, and such a demand is in itself no little recommendation as to its merits. The author of the book, Mr. Stephen Paget, was for twelve years secretary to the Association for the Advancement of Medicine by Research, and it was therefore his business "to know something about experiments on animals, and to follow the working of the (Vivisection) Act of 1876." He is therefore to a peculiar degree competent to write a book dealing with these subjects, and it is a matter for congratulation that the council of the Association above mentioned decided that the book should be written with a view to general reading. Though in this present edition all references to anti-vivisection societies and their methods are very wisely omitted, yet the obvious purpose of the book is to combat the misleading statements which these societies have disseminated broadcast amongst the uninstructed public, and to afford information concerning the results achieved by such experiments on animals, whereby the public may be enabled to judge for themselves as to the claims of the anti-vivisectors. To quote Lord Lister, who writes an introduction to this volume,

"The action of these well-meaning persons is based upon ignorance. They allow that man is permitted to inflict pain upon the lower animals when some substantial advantage is to be gained; but they deny that any good has ever resulted from the researches which they condemn."

Mr. Paget's object is therefore to convey to the general reader some idea of the inestimable advantages which have accrued to medical science from experimental research on animals. In the closing pages of the book, moreover, he points out that the vast majority of the experiments carried out at the present day in Great Britain involve no pain at all to the animals operated upon. The comparatively few animals subjected to painful experiment

"cannot be compared with the same number of horses, cattle, or sheep mutilated by breeders and farmers; for these mutilations are done, some of them, without any anæsthetic. They cannot be compared with the same number of pheasants or rabbits badly wounded, but not killed, in sport; for the animals thus wounded receive no subsequent care, and, if they are in pain, nobody puts them out of it."

To come to the actual contents of the book, we find that Mr. Paget devotes more than 200 pages to the consideration of experiments in bacteriology, but only 84 pages to experiments in physiology. It is to be regretted that the subject which forms the foundation of all medical science should be treated so cursorily, but in excuse it may be admitted that the practical importance of much physiological work is indirect, whilst that of bacteriological work is obvious and immediate.

In his account of experiments in physiology, Mr. Paget gives a concise *résumé* of certain chapters in the history of physiology. The circulation of the blood is treated rather more fully than other subjects, though Harvey's work receives but four pages of description and quotation. In the chapter on gastric juice, Mr. Paget very pertinently refers to the well-known case of Alexis St. Martin, in whom a permanent gastric fistula was produced by a gun-shot wound. Yet in spite of the numerous experiments made upon this man by Dr. Beaumont, no pain was experienced. Presumably, therefore, artificially produced fistulæ in animals are equally painless. In the chapter upon the nervous system, the important results obtained by Galen are described, and it is pointed out that the men who followed after him, though they worshipped his name, missed the whole meaning of his work through their neglect of the experimental method which he employed.

In his pathological chapters Mr. Paget gives a brief account of inflammation and suppuration, and then passes on to serum therapeutics. As the book is admittedly for general readers, it is a pity that no general introduction to this subject is given. The meaning of antitoxins and their method of preparation are nowhere described. The various chapters adduce a very copious body of facts as to the cure of diseases by serum-therapy and preventive inoculation, but the absolute necessity for experiments on animals, not only for the discovery and elucidation of the curative and preventive methods, but for the direct derivation of the immunising sera, is implied rather than clearly stated in so many words. In fact, it looks

rather as if the author had for the time being forgotten the primary object of his book, and had become so carried away by the intrinsic interest of his subject as to be oblivious to the fact that most of his readers must be entirely ignorant of the rudiments of preventive medicine. With this slight criticism we may pass on to enumerate some of the contents of this section. After chapters on anthrax and tubercle comes a very long one on diphtheria, in which an almost unnecessarily full list of statistics is given. In the chapter on rabies we have an admirable description of Pasteur's discovery and method of preparation of rabies virus. The cholera chapter is no less interesting. The plague chapter gives a detailed and most instructive account of the report of the Indian Plague Commission. Judging from the evidence adduced, this report seems unduly pessimistic, and one would have thought the commissioners entitled to go beyond their finding that "the method of serum-therapy is in plague, as in other infectious diseases, the only method which holds forth a prospect of ultimate success." In the typhoid chapter we are interested to learn that of the 12,234 officers and men forming the military garrison in the siege of Ladysmith, 1705 were inoculated against typhoid fever, and that amongst these the proportion of typhoid cases was only 1 in 48.7, whilst amongst the uninoculated it was 1 in 7.07. Still, there is nothing to indicate whether the inoculated were a fair sample of both men and officers, or were chiefly composed of the latter. The intensely interesting chapter on malaria and yellow fever gives an admirable epitome of the most important work done and results achieved in the elucidation of the cause and prevention of these diseases, and should be read by everyone who is compelled by circumstance to live near fever-haunted spots. Still other chapters deal with myxœdema, the action of drugs, and snake-venom, whilst the book closes with an account of the Vivisection Act and inspectors' reports.

H. M. V.

CHEMICAL TESTS AND THEIR DISCOVERERS.

Tests and Reagents, Chemical and Microscopical, known by their Authors' Names. Compiled by Alfred I. Cohn. Pp. iii+383. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 3 dollars.

THE appearance of this volume reminds one of two opposite tendencies that are developing in the terminology of modern chemistry. On the one hand, and more particularly in the "organic" division of the science, the chemist nowadays eschews all trivial or popular terms for his compounds, and strives to find appellations for them which shall be not merely names to remember the substances by, but titles which, at least to the initiated, are more or less self-explanatory. This is very meet and proper, and indeed some such system is probably unavoidable. But the union of the titular with the descriptive, *mariage de convenance* as it is, often produces some very ungainly offspring. Under the writer's eye there lies a recent volume of the *Journal* of the Chemical Society, several pages of which are plentifully besprinkled with such "names" as Ethylbromoketohydroxydihydropentanthrenedicarboxylate, and this is by no means the worst example that could be cited. Mark Twain once remarked of certain German polysyllabic achievements that they were "not words, but alphabetical processions." Similarly one may say of productions like the one above quoted that they are not names, but descriptive sentences with the verbs left out.

On the other hand, the instinct for brevity—combined sometimes, perhaps, with a suggestion of hero-worship or a tinge of Chauvinism—has simultaneously asserted itself in the upgrowth of a kind of personal nomenclature for numerous things chemical and matters microscopical. We have A's test and B's process; C's reagent and D's reaction; E's "number" and F's "value"; G's theory and H's "law"; every month sees additions to the list; and of the making of these minor immortals there seems no end. Time was when the cognominal designation was a distinct convenience. Perhaps it is so still, but in proportion as the number of such titles increases their utility diminishes, and if the hyphenless monstrosities of organic chemistry are sometimes almost undecipherable from their length, the proper names have become confusing by their multiplicity.

These now need, in fact, a dictionary to themselves. So far as tests and reagents are concerned, such an aid is furnished by the present volume. It gives in alphabetical order many hundreds of proper names by which various chemicals and operations are more or less generally known, and after each name describes, usually in a few words, the essential features of the test or reagent with which the name is associated. Most of the matter has already been published serially by the compiler in Merck's Report, and the amplified instalments are now collected in a single volume, where they will be found very convenient for reference.

What chiefly strikes one on looking through the book is that its value would have been much enhanced by the inclusion of more references to original descriptions, of which, indeed, only a very few are actually given. The increased space required would, surely, have been amply compensated by the greater utility secured. On account of the condensed style in which the descriptions are generally written, they are apt to be sometimes obscure; indeed, their chief value in many cases is that of a reminder to one who is already more or less familiar with the operation described. A person who had never previously performed the experiments would often want more detail, but as to where he could obtain it the author gives him no inkling. Nevertheless, the book will be of service to the busy chemist or microscopist. It does not claim to be a complete record, but there is a good deal of information given, and it appears to be generally accurate in substance if sometimes awkward in expression.

An index of subjects closes the volume, and is rather a curiosity in its way, since the body of it is made up almost entirely of proper names. The book may well find a place with the compiler's "Indicators" on the shelves of the chemical laboratory, and will be found useful in the microscopist's workroom.

C. SIMMONDS.

OUR BOOK SHELF.

Dictionary of Philosophy and Psychology. Vol. ii. Edited by J. M. Baldwin. Pp. xvi+892. (London: Macmillan and Co., Ltd., 1902.) Price 21*s.* net.

THIS, the second of the three volumes of Prof. Baldwin's dictionary, completes the text, for the third volume is to consist wholly of bibliographies. As in the case of the first volume, many of the articles are of high merit, but the standard of achievement varies pretty widely. The editor has taken a very liberal view of the range of subjects that call for notice, with the result that the ground is very completely covered, and place is given to a considerable number of topics in physical and biological science which a generation ago would hardly have been mentioned in a dictionary of philosophy or psychology. Perhaps the most valuable articles are those written by Dr. Stout and Prof. Baldwin conjointly, and forming a fairly complete series of careful definitions of psychological terms. We should like to have seen recognised the claims of psychology to rank as an independent science, freed from its ancient bondage to metaphysical philosophy, and if all that pertains to psychology had been brought together in a separate volume it would have formed a more useful, because more manageable, work of reference for the psychologist. The treatment of some topics suffers through being distributed under many separate headings, *e.g.* social science is treated of under that heading, but also under social dynamics, social evolution, social philosophy, sociology, social ethics, &c. Other subjects, again, suffer through being treated by too many hands, working not conjointly, but separately, and with imperfect coordination, so that we even find definitions begun by one writer or writers and finished by another, and in some cases conflicting views within the limits of one article. This is especially the case in the long article on vision. The biographical notes are unsatisfactory, because so very brief, and we note some slight inaccuracies, *e.g.* the description of G. H. Lewes as an English positivist, of R. H. Lotze as professor at Leipzig. These, however, are but small blemishes in a work that should be found very useful, not only by the philosopher and general reader, but by all students of psychology and the other biological sciences. It is interesting to note that "psychical research" receives formal recognition as a legitimate subject for study and research by the inclusion of several excellent articles from the pen of Mrs. Sidgwick.

How to Attract the Birds. By Neltje Blanchan. Pp. 244; illustrated. (London: W. Heinemann, 1903.) Price 5*s.* net.

WHETHER the author of this book should be addressed as Mr., Mrs., or Miss, and whether the name which appears on the title-page be real or assumed, we cannot determine, but we have little hesitation in saying that this and other works by the same pen have a charm and a freshness by no means apparent in all the bird-books which have come under our notice. Although written in America, and treating solely of American birds, the present work, like its predecessors, can scarcely fail to appeal to the English reader and bird-lover; and many of the hints given as to the best mode of attracting and keeping birds in gardens and plantations on the other side of the Atlantic will be equally applicable in the case of our native British species. On one point the author is very emphatic—namely, the impossibility of getting a large number of shy and attractive birds to frequent and build in a garden when a cat is also kept on the establishment. Not only are such attempts unsuccessful, but they are also cruel. In America, where garden crops and produce suffer perhaps even more damage from insects than is the case in this country, the small expenses connected with populating an estate with birds are more than compensated by the accruing advantages to fruit and flowers by the destruction of insect life.

"One pair of chickadees (whatever these may be) in an orchard," writes the author, "will destroy more insect eggs than the most expensive spraying machine." Apparently, indeed, the author will not allow that any bird can do harm in a garden; but then he (or she) has probably never seen a flock of bullfinches in a gooseberry plantation, or witnessed the mischievous devastation inflicted on a primrose-border by sparrows!

An attractive feature of the book is, of course, the numerous, and for the most part exquisite illustrations, more especially those of nests and eggs. In the case of some of the adult birds represented in foliage, we have a shrewd suspicion that they have been "faked up" by means of stuffed specimens, but even then the general effect is in most cases good. While devoting much attention to the proper subject of the book, the author by no means omits reference to the scientific aspects of ornithology, and the observations with regard to the white "recognition marks" on the loins of birds like our own wheatear are worthy of all attention. As a whole, Neltje Blanchan's latest work may be pronounced a charming and attractive volume.

R. L.

Telephone Lines. By W. C. Owen. Pp. xvi+390. (London: Whittaker and Co., 1903.) Price 5*s.*

THIS book deals in a thoroughly practical manner with the construction and erection of overhead telephone lines and the laying of underground cables. The author's long experience as a telephone engineer enables him to write with authority on the subject, which he treats in all its important engineering aspects, from the best methods of preserving the wood used for poles to the final electrical testing of the finished line. American and continental practice is described as well as British methods. Telephony has always been regarded as a branch of applied science in which this country can by no means claim to be to the fore; the perusal of Mr. Owen's book certainly lends support to this belief, as the examples of continental methods which are quoted show in many instances considerable superiority. The theoretical explanations which are here and there required to show the necessity of certain methods of construction are expressed in clear and non-technical language well suited to linesmen and others who are not technical experts, for whom the book is largely written. A large number of illustrations help to explain the text; the book should prove very useful to those engaged in, or having anything to do with, telephone work, and may, moreover, be read with interest by all who care about the practical applications of science.

M. S.

The Globe Geography Readers. Intermediate. Our Island Home. By Vincent T. Murché. Pp. 293. (London: Macmillan and Co., Ltd., 1903.) Price 1*s.* 6*d.*

IN the introductory and junior readers belonging to this series, already noticed in these columns, the young pupil is provided with simple explanations of the general principles underlying the study of geography; the present volume deals specifically with the physical and political geography of the United Kingdom in fifty-six short lessons, the subject-matter of which is varied and discursive, ranging from an account of the prehistoric inhabitants of Britain to a description of Irish scenery. The lessons are written in an interesting, conversational style, and are accompanied by an abundance of instructive illustrations, including sixteen coloured plates.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Psychophysical Interaction.

I MUST demur to the statement of my views which Sir O. Lodge has given in his letter printed in NATURE for May 14, "that if dynamical laws are exact and irrefutable, the universe must be a completely determined mechanical system, with only one, and that a necessary, solution." In the first place, I made no statement as to the universe as a whole; as I do not know the physical universe to be finite in extent, I prefer to make statements only about finite portions of the universe, and the interactions of such finite portions. I certainly hold the view that the laws of dynamics, which are a self-consistent system of formal laws, are exact and irrefutable, but the question whether the motions of all parts of a living organism are in accordance with those laws is quite another matter, and one on which I have expressed no opinion. What I did in effect say, was that a material system upon which forces of psychical origin and of incalculable magnitude acted, traversed the laws of dynamics in the only sense in which such a system of laws can be traversed, viz. that the motions would not be in accordance with the laws, whether the supposititious forces do mechanical work or not.

Sir O. Lodge maintains that the psychical and the physical can interact without upsetting any fundamental dynamical law; he objects to the principle of Least Action as containing assumptions which beg the question at issue, and pins his faith to Newton's laws. Now, although the principle of Least Action contains nothing which is not deducible from Newton's laws, provided the same form of energy-function is taken in the two cases, I will, for the sake of argument, accept the test that Sir O. Lodge lays down. One of Newton's laws is that to every action there is always an equal and opposite reaction, or every stress has two aspects; now I suggest for Sir O. Lodge's consideration the following questions:—What are the reactions corresponding to the forces of psychical origin which act upon parts of a living organism? On what do such reactions act? It will clearly not suffice to say that the reactions are something of a different character from the actions, and are appropriate to exert an influence upon the psychical; Newton's reactions are mechanical forces acting upon material systems.

As an example of a mechanical system the motions of the parts of which are determinate through the laws of dynamics in conjunction with the law of gravitation, we may take the solar system, supposing each member of it to be treated as a whole. Let us suppose that there resided in the solar system some agency of a non-material character which was capable of applying to the planets forces of unknown magnitudes along the normals to their orbits relative to the centre of gravity of the system. The paths of the planets could then no longer be calculated; in fact, there would be an end of gravitational astronomy; both the linear and angular momenta of the system, so far from being conserved, would become absolutely indeterminate, and yet Sir O. Lodge must in consistency maintain that the laws of dynamics would not be traversed. Moreover, although the sum of the potential energy and the kinetic energy of the motions relative to the centre of gravity would be unaltered, the energy of the motion of the whole system through space would be altered to an unknown extent. If the disturbing forces acted normally to the paths relative to a point regarded as a fixed origin for the sun and stars, the energy of the system would be conserved, but in all other respects the same result as before would ensue, namely, chaos.

There are, I take it, in the main three views which may be maintained as regards the relations of the psychical and the physical in living organisms.

(1) The view known as pure naturalism, that the physical forms an independent system, and the psychical is only a *Begleiterscheinung* influenced by, or perhaps determined by, the physical, but exerting no influence on the physical. In this case the motions of the physical are entirely determinate in accordance with mechanical laws.

(2) The view that the psychical and the physical form two systems linked together, with interaction between the two; on this view neither system is complete in itself, and the physical cannot be determined completely by any system of purely mechanical laws. This view does not exclude pure determinism as regards the whole complex, since it may be held that the psychical has a dynamics of its own, and that the interaction between the psychical and physical is determinate in accordance with some scheme of laws.

(3) Lastly, it may be held that the dualism of the physical and psychical is entirely inadequate as an ultimate formulation; in fact, that both (1) and (2) are unworkable as thorough-going hypotheses; on this monistic view, both the physical and the psychical must be regarded as manifestations of something more fundamental than either. This view, as also (2), does not exclude the partial and tentative application of mechanical laws, even to the case of living organisms; there may be a partial or practical independence of the physical in certain classes or cases, but such practical independence could never be presumed apart from proof of its existence by means of actual observation, and there must certainly be a point at which the practical independence breaks down, and at which the dualism of our ordinary mode of thinking becomes inadequate as a representation of what happens. It is this last view of the matter which I am inclined, personally, to regard as the true one.

E. W. HOBSON.

Christ's College, Cambridge, May 17.

WITH the help of one of Clerk Maxwell's demons a very simple illustration of change of motion in a dynamical system, without any interference with the sums of energy and momentum, can be constructed, which may perhaps be of service to Mr. McDougall.

Let the demon provide himself with some inextensible, perfectly flexible, mass-less string. (It is found abundantly in text-books of Dynamics.) Let him observe two bodies of the system, having, it may be, motions of rotation as well as of translation; and when he discovers a point on each the relative velocity of which with respect to the other point is either zero or at right angles to the straight line between them, and which also are about to recede from each other, let him, at the very instant when things are so, attach a piece of his string to these two points exactly equal in length to the distance between them. The two bodies will thus be suddenly yoked together without any shock whatever, and consequently without any loss of energy. Their subsequent motions of translation and rotation will be altered by the action of the string; but their total energy and their total momentum will remain entirely unaltered. As soon as the string slacks the demon must be careful to remove it, in order to avoid the possible shock when it again tightens.

If the string be perfectly elastic (so that no energy is dissipated in internal work when the string stretches) instead of inextensible, the demon may attach it to any two points on the surfaces of the bodies without affecting the momentum sum or the energy sum; but so long as the string is at all stretched, a portion of the energy of the two bodies will be stored up in it.

For example, let the two bodies be spheres moving with the same uniform, rectilineal, velocity; and suppose the centre of figure of each to be its centre of inertia. Let each be spinning about an axis through its centre, perpendicular to the plane in which the centres are moving. Then the demon may safely fasten his inextensible string to the two points where the straight line joining the centres cuts the surfaces. There will be no shock, and therefore no loss of energy. There will be also no change in the total momentum of the spheres, whether linear or angular, nor any change in the uniform, rectilineal, motion of their common centre of inertia; nevertheless, when the demon releases them, they may be moving in divergent instead of parallel directions, and with diminished or increased velocities of rotation.

Demoniacal guidance of this kind conflicts neither with the law of conservation of energy nor with that of the conservation of momentum, and so far would seem to contradict Prof. Ward's criticism in his "Naturalism and Agnosticism," vol. ii. p. 83.

J. W. SHARPE.

Woodroffe, Bournemouth.

PROF. MINCHIN raises the question of the desirability, or undesirability, of the use of adjectives with regard to physical principles. If the noun deserve the adjective, and if the meaning of the adjective be clear, it is not easy to see why the word should be omitted. Prof. Tait is cited, rather unfortunately, as the leader of those who apply the word "grand' to the principle of conservation of energy, while refraining from its application to certain other physical principles. Whether or not it be the case that "following his lead, all but the most sober mathematicians use the laudatory adjective when they write about this particular physical principle," it is certain that all but the least sober physicists will see a very real reason for the use of the term—precisely the reason which led Tait to adopt it.

Prof. Tait's use of adjectives is instructive. He made a very characteristic use of the term "mere," a word which Prof. Minchin would abolish along with "grand." He spoke of the mere mathematician, that is, a mathematical machine not possessed by the soul of a physicist.

But Tait did not refuse glorification to the principle of conservation of matter. He placed it, in that respect, on the same high level as the principle of conservation of energy. And he glorified Newton's laws, so glorifying the principle of conservation of momentum and the other principles alluded to by Prof. Minchin.

Tait also knew that it was possible so to state the principle of conservation of energy in a dynamical system as to make it include that of conservation of momentum. This was pointed out in an early chapter of a text-book on dynamics which he never completed.

Assume an origin and axes of reference. Let the (conserved) energy of a system be E_1, so that

$$\Sigma(mv^2) = 2E_1.$$

Assume that the energy is also constant ($=E_2$) when the motions are referred to an origin moving uniformly with speed a_2 in a direction making an angle θ with the line of motion of the mass m, and we get

$$a_2^2\Sigma(m) - 2a_2\Sigma(mv\cos\theta) = 2(E_2 - E_1).$$

Similarly

$$a_3^2\Sigma(m) - 2a_3\Sigma(mv\cos\theta) = 2(E_3 - E_2)$$

if we refer to an origin moving with uniform speed a_3 in the same direction. Hence

$$\Sigma(\dot{m}) = 0. \quad \frac{\partial}{\partial t}\Sigma(mv\cos\theta) = 0.$$

The latter equation asserts conservation of momentum, the former asserts conservation of matter.

In the same way, if we postulate that momentum, found to be conserved when referred to certain axes and a given origin, is also conserved when referred to an origin moving uniformly with regard to this reference system, we can deduce the principle of conservation of matter.

It is impossible that all three—matter, momentum, and energy—can be in general found to be conserved simultaneously when referred to an origin in varying motion. If matter be conserved, and if we could measure, from our standpoint on the earth, the momentum and energy of the universe, we should find one or both to be subject to at least yearly, monthly, daily, &c., periodic variations. If the origin move with the centre of inertia, as in all cases directly experimented upon, all three principles hold if two hold, while the energy is found to be constant in at least one state of motion of the centre of inertia, say zero. The discussion of absolute conservation is as futile as the discussion of absolute motion.

It may be that energy, or momentum, is only conserved on the average as to space and time, the departures being on an ultra-measurable scale and yet sufficient to account for "guidance" action in living beings. But we do not require to postulate this in order to account for guidance action. Such action might occur and yet be in accordance with conservation of both momentum and energy. Maxwell's demons could bring it about. Suppose that the mass of a demon is zero, that he is perfectly elastic, and that his parts are capable of rapid relative motion. Let an army of such demons receive orders to abstract heat from one portion of a body and give it to an adjacent portion, so as to establish a difference of temperature while keeping the total energy constant. Because of his zero mass, each demon must adjust himself, in acting upon molecules, so as to produce zero change of momentum at any instant. He can allow quickly moving molecules to pass in one direction, slowly moving molecules in the other, while he prevents to some extent the reverse process. He might thus work railway points with no expenditure of energy on the whole, and with no change of momentum on the whole. The only principle temporarily interfered with is the principle of dissipation of energy; and that is temporarily interfered with constantly in nature.

Such speculations are of no value except as showing that guidance action *may* occur without overthrowing accepted dynamical principles. Further discussion lies outside physics. As Tait said, "human science has its limits, and there are realities with which it is altogether incompetent to deal." A sufficiently wide Monism is scientific and good.

W. PEDDIE.

University, Edinburgh.

IN his letter on the conservation of energy (p. 31), Prof. Minchin holds that, while energy might be conserved in the physical universe acted on in some way by mind, yet neither force nor momentum would be. "They" (the causes altering the configuration of a system) "infallibly alter its total momentum and total force in every direction."

Even for changes produced by physical causes, *e.g.* the pressure of a smooth rail, this may not be the case. It is true the rail will not guide a moving body along it unless it exerts pressure, and then it will generally alter the momentum of the system, to which the rail itself is not supposed to belong. It may happen, however, that the pressure from without is exerted in equal amount in opposite directions. Further, if it were true that the total momentum would be infallibly altered by a *physical* cause, this would prove nothing for psychophysical action, unless we beg the whole question, and assume at the outset that the motion of matter can only be affected by what is material.

The constant use of physical analogy in this connection soon leads to obscurity. The only resemblance that can at present be said to exist between the action of mind and that of an ideal immovable rail is that both do no work. To explain *how* mind acts on matter, such analogies are useless. At most, in the case under discussion, they can only serve to show that there are possible causes of change which do not affect the energy. It is only, I think, an undue use of physical analogy—the action of the mind, for instance, being thought of as pressure—that can prompt the statement that any cause of change must alter the total momentum in some direction.

The laws of mechanics are merely regulative, and are not of themselves sufficient to account for the motion of a dynamical system with given initial conditions, unless it is stipulated that all action is mechanical, or at least unless the action on, or interference with, the motion is exactly defined. This is proved by the simple fact that we can solve examples in dynamics in which we suppose arbitrary, known interference to take place. In such examples, as a rule, the momentum of the system would be altered, but that is not at all necessary.

In conclusion, then, it may be agreed that the action of mind does not violate the laws of mechanics, but that no more prevents mind producing changes than it prevents those produced by ordinary mechanical action.

The University, Birmingham. C. T. PREECE.

Extension of Kelvin's Thermoelectric Theory.

LORD KELVIN'S thermoelectric theory has always seemed to me to be one of his best works. Since its enunciation the scope of the electric current has been extended, as in Maxwell's theory. It is now the curl of the magnetic force of the field always and everywhere. A corresponding extension of the thermoelectric theory is needed. I do not know whether it has been done, but it may be shortly stated, and contains some striking results. As regards the necessity, the following case will show it plainly. Make up a circuit of two parallel wires of different materials, both thermoelectrically neutral, say one of lead, the other of one of Tait's alloys. The places of thermoelectric force in the circuit are then the terminals. Now send short waves along the circuit, in the way so often done of late years. There need be no current at all in the circuit at one end to pair with that at

the other. So there is complete failure of the theory of metallic circuits.

But the needed extension is easily made by following Lord Kelvin's method, and using the enlarged meaning of electric current. Let **e** be the intrinsic voltage per unit length due to reversible thermal action, and let **C** be the current density. Then **eC** is the heat per unit volume absorbed per second, and the second thermodynamic law requires that $\Sigma \mathbf{eC}/\theta = 0$, if θ is temperature, the summation to be complete as regards **e**. Here **C** may be any circuital current, so $\mathbf{e}/\theta$ is polar; that is, $\mathbf{e} = -\theta\nabla p$, where p is a scalar, the thermoelectric power. In a homogeneous conductor, p is a function of the temperature only, to suit Magnus's results. But it is also a function of the material. In what way is not known, but it shows itself at the junction of different metals. Then p changes, say, from p_1 to p_2, so the intrinsic voltage at the junction is $P_{12} = \theta(p_1 - p_2)$. This is the Peltier force from the first to the second metal. So far is all that is necessary for steady currents. But when the current varies, part of it leaves the metals. Now at a metal-air junction, the thermoelectric power falls from p to 0, so there is an additional thermoelectric force $P\mathbf{N}$ or $p\theta\mathbf{N}$ acting outwards, **N** being the unit normal. It is here assumed that the thermoelectric power of air is zero. It does not seem likely that its value is important compared with p in a metal. This $P\mathbf{N}$ multiplied by the current leaving the conductor measures the reversible thermal effect at the boundary. The system is now complete, provided there is no external **e**. But should there be, then it must be counted too, if, for instance, a current is induced in an external conductor. In any case, $\mathbf{e} = -\theta\nabla p$ will be valid, with the usual proper interpretation of discontinuities, and the Maxwellian meaning of the current.

It will be sufficient to suppose that $p = 0$ outside a circuit of two metals. Then there is the Thomson force in the metals, the Peltier force at the metal junctions, and the metal-air force $P\mathbf{N}$ of variable intensity all over the circuit. In the extreme case with which I commenced, there may be only one Peltier force in operation, or even none at all, but just the metal-air force alone. If so, there is reversible evolution of heat at some parts, and absorption at other parts of the boundary.

As regards the application of the second thermodynamic law, it seems to be justified by experimental results with steady currents. I see no reason why it should not be applied to variable currents, even when varying very rapidly. For p is a property of the material and its temperature at any place, and has nothing to do at the moment with what is going on at other places. Yet a reservation is necessary. For the second law results from averages. So there must be some limit to the rapidity with which the current at any spot may vary, if the second law is to be fully valid there.

The Volta contact force must not be forgotten in connection with the metal-air thermoelectric force. Mr. J. Brown has lately made the Volta force disappear by heating it away in oil. If this is fully confirmed, it perhaps proves that chemical action between the metal and an electrolytic film of moisture is the real source of the energy of the transient Volta current, as Mr. Brown maintains. How will this affect the thermal force? If we allow properly for the change in p in passing through the film from the metal to the air, it seems likely that the thermoelectric effects will be simply superposed upon the Volta effects, because the sources of energy are different. Yet they might have to be combined in some unknown way.

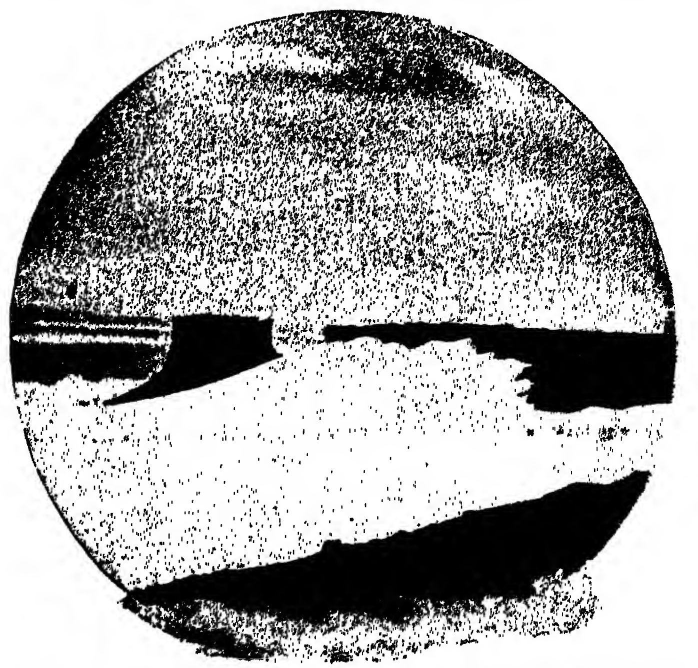
Returning to the steady current in a circuit of two metals, Lord Kelvin showed that the complete intrinsic voltage amounted to $\Sigma p d\theta$. This does not express the real distribution of intrinsic force in the circuit, and seems to have no meaning. But it has a curious interpretation, which is of importance in the extended theory. The necessity of the metal-air force is shown in another way. I have shown that the source of **H** in varying states is the curl of **e** everywhere. Here this is $\mathbf{f} = \mathrm{V}\nabla p\nabla\theta$. It is zero in a homogeneous conductor, and also at the metal junctions, but has the boundary value $\mathrm{V}\mathbf{N}\theta\nabla p$, which would represent the source of **H** if there were no metal-air force. But add on the curl of the metal-air force $P\mathbf{N}$ or $p\theta\mathbf{N}$. It is $-\mathrm{V}\mathbf{N}\nabla P$, and the sum of the two is $-\mathrm{V}\mathbf{N}p\nabla\theta$. Now this is also the curl of the fictitious intrinsic force referred to, that is, $p\nabla\theta$ in the metals only. So we come to this striking result, that Lord Kelvin's $\Sigma p d\theta$ in the metal circuit alone is a fictitious distribution which not only gives the same steady current as the real distribution of intrinsic force, but also gives the true **E** and **H** everywhere in variable states as well, provided the real intrinsic forces include the metal-air forces along with the Peltier and Thomson forces.

OLIVER HEAVISIDE.

May 18.

THE FARTHEST NORTH.

H.R.H. Prince Luigi Amedeo of Savoy, Duke of the Abruzzi, has given to the English-reading public a superb account of his great Arctic expedition.[1] Though he has fortunately adopted a smaller size of volume than his Imperial namesake, the Archduke Ludwig Salvator, devotes to his luxurious memoirs on Mediterranean islands, the book is still both ponderous and imposing. Although in octavo, it is as large as most quartos, and it is a credit to the publishers in every way. A royal opulence is reflected from the burnished pages, which reflect the light also so perfectly that at night it is impossible, without elaborate precautions, to prevent the image of the lamp-flame from concealing part of the text. The very fine half-tone reproductions of photographs with which the book is crammed profit by the quality of the paper. The portraits of Admiral Markham and Dr. Nansen, illustrating the introduction, are not, however, very happily chosen, and we miss a satisfactory portrait of Captain Cagni, the hero of the memorable journey to the farthest north.



IG. 1.—Cape Säulen, seen from the south-east. (From "On the *Polar Star* in the Arctic Sea.")

The royal author writes modestly and well, his

1 "On the *Polar Star* in the Arctic Sea." By His Royal Highness Luigi Amedeo of Savoy, Duke of the Abruzzi, with the Statements of Commander U. Cagni upon the Sledge Expedition to 86° 34′ N., and of Dr. A. Cavalli Molinelli upon his Return to the Bay of Teplitz. Translated by William Le Queux. In two vols.; with 212 illustrations in the text, 16 full-page photogravure plates, 2 panoramas and 5 maps. Pp. 702 + xxii + xii. (London: Hutchinson and Co., 190)

narrative occupying the first volume, and serving to show that he was a good comrade and a brave explorer, sharing all the discomforts of a somewhat miserable wintering without complaint. The translation, too, is well done, running so smoothly that it is rarely recognisable as a translation at all. Now and again, however, little bits of awkwardness come to light. A medical man would hardly write in English of the "digestive tube," nor would a sailor refer to the "left side" or the "chimney" of a steamer—"it's no a lum, it's a funnel," said "Wee Macgreeger" scornfully on one occasion. Trifles of nomenclature also show the want of first-hand knowledge; where the form is so beautiful it jars one to run against a "Thompson" compass, a "Clement" Markham, or even an "Ommaney." We wonder whether the British public nowadays attaches any more definite meaning to a dram as a unit of weight than it does to a gramme; and we are sorry for the task set to poor Dr. Cavalli in weighing out 8oz. 13·0958dr. of tinned meat for each man every day; though we are reassured in finding that the metric units quoted alongside prescribe only the quarter of a kilogramme, and we presume that he did not trouble himself to weigh it to the fifth of a milligramme as the English version suggests. This habit of translating foreign units by some theoretical table is so common that it is really time to put in a plea for the exercise of common sense, which in this case would suggest 8¾oz. as a sufficient equivalent for 250 grammes, and in another would delete a residuum of 4 drams in a weight of nearly a ton.

FIG. 2.—The *Polar Star* after the Ice Pressure. (From "On the *Polar Star* in the Arctic Sea."

The narrative of the Italian expedition has already been summarised in NATURE (vol. lxiv., 1901, p. 158), and it need not be repeated. The first of the volumes before us supplies many additional particulars as to the first navigation of Queen Victoria Sea, and the long struggle with the ice before the *Stella Polare* reached the northern limit of the Franz Josef Land archipelago beyond Rudolf Island. It deals with all the usual incidents of a winter sojourn in high latitudes, made in this case unexpectedly hard by the party being obliged to leave the ship, which had been specially prepared for wintering in, and to camp instead in extemporised tents. There are few references to scientific work, but observations were made and collections obtained which are being discussed in a series of volumes by Italian specialists. Enough is said, however, to show that the observations must have been frequently interrupted. The difficulties of high wind and snowdrift proved much greater than were expected with regard to the meteorological instruments, in the management of which some preliminary experience at a high-level observatory in Europe would have been of great assistance. The magnetic hut, too, suffered from stress of weather; but we hope that the results obtained will yet prove of value.

Most interest naturally attaches to the second volume, which deals mainly with Captain Cagni's fine attempt to reach the Pole. This attempt proved more nearly successful than any sledging expedition before or since, and it is narrated by the captain himself. There is no doubt that if the commander of the expedition had sufficiently recovered from the serious frost-bite from which he suffered he would have led the advanced party to the farthest point. The pluck and endurance of the Duke of the Abruzzi have been amply proved, while the fact that when himself disabled he insisted none the less on his second in command carrying out the programme speaks volumes for his generosity and patriotism. The expedition was a private one, planned to gratify the laudable ambition of an illustrious personage, and no one could have reasonably objected if the commander had changed his plans and stopped the expedition when he found he could go no farther. Captain Cagni and the three Italian alpine guides who accompanied him were worthy of the confidence reposed in them, and they were rewarded by being able to carry the Italian flag a little nearer to the Pole than the flag of any other nation has yet been taken. Beyond observations of latitude, no scientific work was possible on this arduous journey; but the result showed clearly that, given a sufficiency of dogs, no piece of polar travel need prove too difficult for resolute men. The dogs of the *Stella Polare* not only drew the sledges, but, as in Nansen's case, they furnished a food-supply for their surviving comrades, and in this case towards the end for the explorers themselves. It is curious to find that the exhaustion of provisions, or even of the petroleum used for fuel, excited comparatively little interest so long as a few dogs were left to furnish

meat and grease to burn for cooking it; but the utmost anxiety was caused by the wearing out of the aluminium stove and cooking utensils. As regards clothing, the Italians found woollen material much more useful and satisfactory than furs. The point is discussed at some length by Dr. Cavalli, who observed that light porous cloth allowed the perspiration to pass to the outside before freezing, and there it could be scraped off and the clothes kept comparatively dry; whereas when skin clothing of any kind was used, snow and ice were formed on the inner surface, and when warmed in the sleeping-bag the clothes were saturated with moisture.

The Italian and Norwegian members of the expedition appear to have been on the best of terms throughout, and but for the loss of the first party returning from the great journey over the sea-ice, their year in the Arctic regions must be pronounced a most successful one. What is now wanted in the interest of science is no mere dash to the Pole, no more experiments as to modes of travelling, but a repetition of the drift of the *Fram* from a point north of Bering Strait, with abundant equipment for oceanographical, meteorological and magnetic research. It would cost but a trifle compared with the expense of an expedition with dogs and stores enough to ensure reaching a very high latitude from any land base, and the value of the results is certain, though five years might not be too much to allow for obtaining them. It is a great opportunity, ready for some wealthy person with a love of solitude and science.

THE RESTORATION OF THE LAND OF CHALDEA.

TWO lectures by Sir William Willcocks, late Director-General of the Irrigation Works in Egypt, delivered before the Khedival Geographical Society at Cairo, have been published in a pamphlet,[1] a copy of which has been received. Sir William Willcocks, as is well known, is an enthusiast in irrigation matters, and has had a very large share in bringing Egypt to its present state of prosperity by the reorganisation of the canal and reservoir system, and in designing the new works that have recently been carried out at Assuan. The pamphlet under notice relates to the ancient country of Chaldea, which bears a great resemblance in its physical features to Egypt, the river Tigris being capable of performing the same functions as the Nile.

In view of the proposed Bagdad Railway, which will traverse this delta, the subject is of considerable interest. The author's view is that the resuscitation of the ancient canal system would create along the line of railway a country as rich as Egypt, the rent of which would pay for both railway and irrigation works, and leave a surplus "which only those can realise who have been in intimate touch with Egyptian Agriculture."

Bagdad lies at a distance of about 500 miles from the sea, measured along its course. From the city to the Persian Gulf is a country now completely desolate, but which formerly was one of the most fertile and populous districts in the world. Opis, situated on the banks of the Tigris, and which was at one time the wealthiest mart of the East, bears to the delta of the Tigris very much the same relation that Cairo bears to the delta of the Nile; and here were situated the head of the great canals which irrigated the delta. The great Nahrwan canal had its intake in this locality, and extended for a length of about 250 miles, feeding an immense number of subsidiary canals. This canal, for the first ten miles of its course, was cut through hard conglomerate rock to a depth of 50 feet, and was 65 feet wide, increasing lower down to 394 feet. These dimensions considerably exceed those of the largest irrigation canal in Egypt. It was described as late as 970 A.D. as flowing amid continuous and extensive villages, date groves, and well-cultivated lands, the whole region over an area of 4600 square miles containing a population, judged from the ruins left, that no spot on the globe could excel. Owing to neglect of the works the main stream of the Tigris became diverted, the old bed of the river silted up, and the ruin of the irrigation system became complete, and now the ruins of Opis and many other mounds of adjacent buildings spread like islands over the deserted plain, which is quite bare of vegetation. The author of the pamphlet estimates that there are about one and a quarter million acres of first-class land of the value of 38,000,000*l.* that could be reclaimed and once more made prosperous by an outlay of 8,000,000*l.*, and which would produce a rental of 3,840,000*l.* Beyond this is an area of one and a half millions of acres of less fertile land, that could also be reclaimed and cultivated.

The second lecture is a description of what Egypt will be in fifty years' time, according to the author's ideas, when the country "will attain a height of splendour and magnificence." which will surpass the great works of the days of the Pharaohs, which have survived the revolutions and catastrophes of four thousand years.

[1] "The Restoration of the Ancient Irrigation Works of the Tigris; or, the Re-creation of Chaldea"; and "Egypt Fifty Years Hence." By Sir William Willcocks. Pp. 71; with 10 plates. (Cairo: National Printing Department, 1903.)

THE DALTON CELEBRATIONS AT MANCHESTER.

THE Manchester celebrations in connection with the centenary of Dalton's atomic theory began on Tuesday afternoon, May 19, when Prof. F. W. Clarke, chairman of the International Commission on Atomic Weights, delivered the "Wilde" lecture on "The Atomic Theory" to the Manchester Literary and Philosophical Society. Addresses were presented on behalf of the Royal Society and the Chemical Society, and a message was received from the Russian Physico-Chemical Society. In an admirable discourse Prof. Clarke sketched the history of the atomic theory from its first conception in the minds of Greek philosophers down to the present day. He pointed out the directions in which the atomic theory would probably develop, but declared that the problem of matter would never be solved until the atomic weights of the elements had been finally settled. "Who," he asked, "will establish the Dalton Laboratory for pure research, and so give the work which he started a permanent home?"

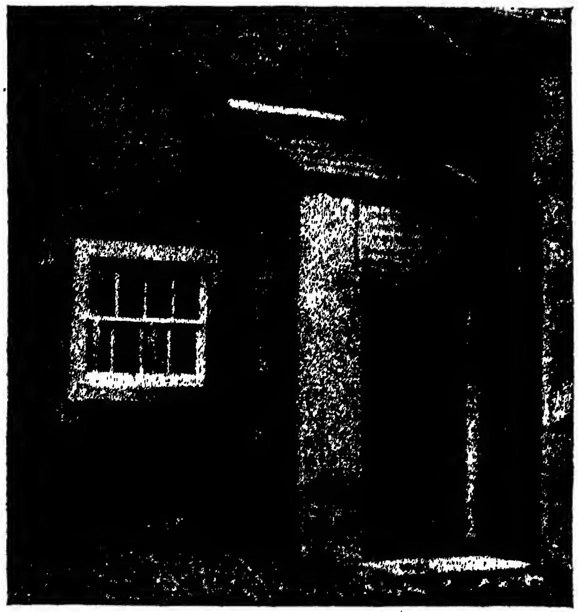
In the evening the Literary and Philosophical Society gave a dinner, at which the principal guests were Profs. Clarke and van 't Hoff, Prof. A. E. Armstrong, Mr. Brereton Baker, Prof. P. F. Frankland, Mr. Vernon Harcourt, Dr. Harden, Sir James Hoy, Prof. Kipping, Dr. W. H. Perkin, sen., Sir William Ramsay, Prof. Emerson Reynolds, Sir Henry Roscoe, Prof. Smithells, Dr. Scott, Prof. Thorpe and Prof. Tilden.

In proposing the toast of the evening, the "Wilde" medallist—Prof. Clarke—and the Dalton medallist—Prof. Osborne Reynolds—Sir Henry Roscoe said that Dalton's atomic theory and Joule's discovery of the mechanical equivalent of heat reflected more distinction on Manchester than the city's association with the cotton industry or with the Ship Canal.

On Wednesday morning a special meeting of the Owens College Chemical Society was held to offer an address to the great Dutch chemist, J. H. van 't Hoff, now professor at the Berlin University. Prof. Dixon

was in the chair. The address was presented by Mr. Norman Smith, a former student under Prof. van 't Hoff. The professor, who was enthusiastically received, said the question was often asked, nowadays, whether the atomic theory had not outlived its utility. His reply was that, in dealing with natural phenomena, with states of unstable equilibrium, the atomic theory was indispensable for essential explanations. He had come to regard the conception of the carbon atom as the centre of a tetrahedron as childish, but it contained the germ of a profound truth, the solution of which must be left to the future. He suggested that valency was due to an equilibrium. The four mutually repellent "electric atoms" of Helmholtz were kept in equilibrium by their attraction for the carbon atom at the centre.

Later in the morning Earl Spencer, Chancellor of the Victoria University, conferred the honorary degree of Doctor of Science on Prof. Clarke and Prof. van 't Hoff, who were presented by Prof. Dixon. After the conclusion of the ceremony Prof. van 't Hoff laid the



Memorial Tablet over door of house in which John Dalton was born. From a photograph supplied by Mr. A. Humphreys. The inscription on the tablet reads:—"John Dalton, D.C.L., LL.D., the Discoverer of The Atomic Theory, was born here Sept. 6, 1766. Died at Manchester July 27, 1844."

first stone of the proposed extension of the Owens College Chemical Laboratories, and was presented, as a memento of the occasion, with a silver trowel by the College Chemical Society. The celebrations were concluded by a soirée held at the Owens College on Thursday night, when Dr. Harden gave an interesting account of John Dalton, and many Dalton relics were exhibited by the Manchester Literary and Philosophical Society, Prof. H. B. Dixon, Mr. Theodore Neild, Mr. G. W. Graham and Mr. G. S. Woolley. E. C. E.

THE ATOMIC THEORY AND THE DEVELOPMENT OF MODERN CHEMISTRY.

MANCHESTER celebrated last week, just a little prematurely, the centenary of John Dalton's atomic theory. It was on September 6, 1803, that he drew up in his notebook his first table of weights of the "ultimate atoms" of hydrogen (which he took as his unit), oxygen, "azot," carbon, sulphur, and of water, ammonia, nitrous gas, nitrous oxide, and other binary compounds of these elements. With regard to the genesis of the theory in his own mind much doubt has prevailed until recently. Dalton himself told Thomas Thomson in 1804 that he had been led to the theory from his work on marsh gas and olefiant gas. He told W. C. Henry in 1824 that his speculations were suggested by the work of Richter. And yet, oddly enough, as Sir Henry Roscoe and Dr. Harden have shown in their "New View of Dalton's Atomic Theory" the evidence is dead against the accuracy of these plausible statements. Dalton's own notebook shows that his atomic theory preceded his work on marsh gas, and his notes for a lecture delivered in 1810 give a history of his ideas which agrees with all the facts.[1]

It was from Newton that Dalton derived his belief in the atomic hypothesis. And we can trace the "solid massy, hard, impenetrable, moveable particles" of Newton, through his friend Boyle, through Gassendi, and through Bacon (who considered Democritus to be the greatest of Greek philosophers) back to Epicurus and to the originators of the atomic theory, Democritus and Leucippus. Dalton's theory of atoms is historically the Greek theory of atoms. But with a difference.

Boyle, who was a far more thoroughgoing atomist than is generally supposed, really rejects the hypothesis of different elements which he himself originated, considering that differences of atomic structure and arrangement of a single form of matter would account for all chemical transformations.[2]

But Boyle's own definition of an element, as a substance which could not be decomposed, proved far more fruitful than his atomic beliefs, and the work of his successors—of Marggraf, of Black and Cavendish, of Scheele and Bergman, of Priestley and Lavoisier—had gradually established in the minds of chemists the idea, rejected by Boyle, that there existed a series of elements not convertible into one another. It was to that series of elements, unknown to the ancients, that Dalton applied the atomic hypothesis. He came to the conclusion that the atoms were not of all kinds of shapes and forms, as had been previously supposed, but that the atoms of the same element were all identical in weight, while the atoms of different elements were different in weight. It was an idea that might conceivably have occurred to some chemist fifty years earlier. But, in spite of Black's work, the phlogiston theory had led chemists before Lavoisier to lay small stress on the notion of weight. Dalton could hardly have come much earlier than he did. The first announcement of his theory was made in a paper read in October, 1803, at a meeting of the Manchester Literary and Philosophical Society, in the house of which he had his laboratory; the paper was not published until 1805. Dalton's views were not fully placed before the world until the publication of the first volume of his "New Systems of Chemical Philosophy," in the years 1808–1810.[3]

Meanwhile Dalton had been carrying out researches which confirmed his view, and, together with certain assumptions, led to the most important of generalisations. Dalton himself never disengaged the

1 Save for an obvious clerical error of 1805 for 1803.

2 "I see not, why we must needs believe, that there are any primogeneal and simple bodies, of which, as of pre-existent elements, nature is obliged to compound all others. Nor do I see why we may not conceive, that she may produce the bodies accounted mixt out of one another by variously altering and contriving their minute parts, without resolving the matter into any such simple or homogeneous substances, as are pretended" ("The Sceptical Chymist," part vi., folio edition, vol. i., p. 369). See also p. 366, a reference to an experiment by which Boyle thought he had "destroyed refined gold and brought it into a metalline body of another colour and nature"; and p. 367, an earlier announcement of the view just quoted.

3 The first part of this volume appeared in 1808, the second in 1810. The first part of the second volume only appeared in 1827. The work was not completed.

facts from the theoretical language in which he clothed them. But we may say, broadly speaking, that Dalton's atomic theory led to the establishment of three fundamental laws of chemistry, the law of definite proportions,[1] the law of multiple proportions (which really includes the law of definite proportion) and the law of equivalents. The fact that elements unite in more than one ratio by weight obviously made further assumptions necessary, over and above the atomic hypothesis, before any table could be drawn up of relative atomic weights. Dalton seemed to have felt no hesitation in making the assumptions that seemed to him convenient ("New System," part i. p. 214). But Wollaston, while giving Dalton's theory his powerful support, showed, in 1814, that Dalton's assumptions were arbitrary, and Wollaston's term "equivalent," which was regarded as implying no hypothesis, soon became a serious rival to the term "atomic weight." Davy, to whom (with Henry) Dalton had dedicated part ii. of the "New System" in 1810, gave Dalton's views a reception more than cool.[2]

Among the great chemists of the day, it was to Berzelius, who had already been trying to extend the quantitative work of Richter, that Dalton's views appealed most. But Berzelius, less imaginative, but more critical a thinker and more accurate a worker, than Dalton, saw that much remained to be done before the theory could be placed on a satisfactory basis. "I think," he writes to Dalton, "that we must let experiment mature the theory." Berzelius's admirable "Essai sur les Proportions chimiques" of 1819[3] gives the first critical account of the atomic theory, while the experiments recorded therein may be regarded as having first placed the laws of multiple proportions and of equivalents on a sufficiently wide basis to be regarded as generally valid.

Nevertheless, the conviction that chemistry could do quite well without the conception of atoms, and that the notion of "equivalents" was sufficient, grew steadily; between 1840 and 1850 Leopold Gmelin's system of equivalents came to be accepted almost universally.[4] It was the growth of organic chemistry and the confusions in organic chemistry which the "equivalent" conception was powerless to remove that restored the notion of the atom. From 1842 onwards Laurent and Gerhardt, those two Ishmaels of their day, fought indefatigably for the establishment of some consistent theory of organic compounds; and they reached consistency only by reviving the simple molecular hypothesis of Avogadro and Ampère.[5] This hypothesis gave them at once an experimental method for the determination of the relative molecular weights of all volatile compounds; and it gave them simultaneously a method for determining maximum values for the atomic weights of the elements therein contained, for obviously each molecule must contain at least one atom. But neither they, nor Cannizzaro later, were able to give any simple rule applicable in all cases to the determination of atomic weights. The atomic weight of carbon on which the reform of Laurent and Gerhardt pivoted was an exception to the rule of Dulong and Petit on which Cannizzaro, with general approval, has laid so much stress. But a hypothesis may be useful without being perfect. The atomic hypothesis in the hands of Wurtz, Hofmann, Williamson, Frankland, Kekulé, and Baeyer, and with the most brilliant and essential but involuntary help of Berthelot and of Kolbe, was the instrument which served to build up modern organic chemistry. It gave chemists an unforeseen mastery over the elements; the synthesis not only of the natural organic compounds, but of an infinity of new ones seemed to be brought within their reach. In this development Manchester had again played a part of first-rate importance. Frankland's theory of valency was based on his researches on the organometallic bodies carried out in the Owens College, where he was professor, and published in 1852. The exact *rôle* of Frankland's work on valency (neglected at first by most chemists) was this: it forced his friend and fellow worker, Kolbe, to abandon the Berzelius copula theory, and led him to build up "constitutional" formulæ for the chief alkyl compounds so near our own that he was enabled to predict from them the existence of secondary and tertiary alcohols. The formulæ of Kolbe, with the atomic weights of Gerhardt, again led inevitably to the great theories of Kekulé on the tetravalency of carbon and the linking of the atoms, which are now regarded as fundamental in organic chemistry.

In 1875, new horizons were brought into view. Wollaston predicted of Dalton's atoms in 1808 that "the arithmetical relation alone will not be sufficient to explain their mutual action, and that we shall be obliged to acquire a geometrical conception of their relative arrangement in all the three dimensions of solid extension." Le Bel and van 't Hoff, by their work on the "asymmetric" carbon atom, created a new "chemistry in space," of which one of the most striking results has been the beautiful synthesis of the sugars, by Emil Fischer and his fellow workers. Prof. Pope has recently extended these new ideas to inorganic chemistry with brilliant results.

But such exceptional results as those of Prof. Pope bring sharply into view the fact that the direct service of the atomic theory to inorganic chemistry has been relatively small. What, for instance, has the theory of valency to tell us about such a series of compounds as the tungsten chlorides discovered by Roscoe? But if the atomic theory has helped us comparatively little in determining the constitution of inorganic compounds,[1] it has contributed to our discovery of new inorganic elements. The attribution of certain numbers, equivalents or atomic weights, to the elements led naturally to speculation on mathematical relationships between them. Many of these speculations, like the original one of Prout in 1815, and that of Dr. Henry Wilde, of Manchester, more recently, were suggested by the fascinating question of the fundamental unity of all matter. Are the elements really compounds of one original matter—the *protyle* of the Greeks revived by Prout and by Sir W. Crookes? If so the atomic weights must have some common measure. On the accurate determination of atomic weights, made largely to settle this question, infinite pains have been spent by Stas, Marignac, Richards, and many others. On the criticism and accurate calculation of results from these experimental determinations infinite pains have again been spent, by Meyer and Seubert, and above all by Prof. F. W. Clarke, who delivered the Wilde lecture of the Manchester Literary and Philosophical Society at the centenary celebrations last week.

But though certain numerical relations seem striking, chemists are certainly as a body not inclined to acknowledge the existence of any exact formula expressing as a mathematical series the series of the atomic weights.

More immediately fruitful of results have been speculations less fundamentally ambitious. The schemes of Lothar Meyer and Mendeleeff, according

[1] The present writer has briefly discussed the history of this law, in NATURE, vol. l. 1894, p. 149.
[2] In two unappreciative lines in a footnote to the "Elements of Chemical Philosophy," published in 1812 (see p. 78 of the edition of 1860).
[3] The Swedish edition appeared earlier.
[4] Gmelin himself in his "Handbook of Chemistry" inclined to the atomic theory. English edition, translated by H. Watts, vol. i. p. 42.
[5] "Equal volumes of all gases under the same conditions of temperature and pressure contain equal numbers of molecules."

[1] The researches of Divers and of Raschig on certain sulphur and nitrogen compounds may be regarded as examples of what may be done in this direction.

to which the elements, when arranged in the order of their atomic weights, take their place on a kind of chessboard, elements resembling one another being in the same row, have led to the prediction of the existence of new elements; and even unpredicted new elements, such as the remarkable series discovered by Lord Rayleigh and by Sir William Ramsay, have had a fairly comfortable place found for them by extending the chessboard on ground to which it had some legitimate claims.

Inorganic chemistry has developed recently very largely on the physical side. In much of the work, notably in the applications of thermodynamics (and especially of the researches of Willard Gibbs, whose death we lament), the atomic theory plays no part, or but a small one. In the great studies on solutions, however, originated by van 't Hoff, Arrhenius, and Ostwald, the fruitful *ion* theory formulated by these chemists can hardly be regarded as independent of the atomic theory. And yet, in his last book on inorganic chemistry, Prof. Ostwald employs "the forms of the atomic hypothesis as sparingly as ever the present use of language will permit."[1]

In what has preceded, the atomic theory has been regarded from the point of view of utility. Of its utility to chemistry there can be no doubt. It helps us to describe complicated phenomena briefly. The atomic formula $CH_3.COOH$ reminds organic chemists at a glance of a very large number of properties of acetic acid. But, many will ask, is this atomic theory something more than useful? Is it really true?

The subject has been much discussed of late both by men of science and philosophers.[2] One school regards the methods of experimental science as capable of yielding generalisations that are absolutely true, and some of the members of this school do not hesitate to say that the atomic theory is absolutely true. Sir Arthur Rücker concluded his brilliant address to the British Association in 1901 by declaring that "we have a right to insist—at all events till an equally intelligible rival hypothesis is produced—that the main structure of our (*i.e.* the atomic) theory is true; that atoms are not merely helps to puzzled mathematicians, but physical realities." Even in this most positive assertion of Sir Arthur Rücker with regard to the existence of atoms there remains a shade of doubt. Lord Kelvin, in a subsequent speech, showed that in his mind, at any rate, there was none.

There is, however, another school, the origins of which go back far, but which is identified chiefly with Kirchhoff (the discoverer with Bunsen of spectrum analysis), and with his disciples Mach and Ostwald in Germany, and Karl Pearson in England. According to this school, the discovery of "causes" and of ultimate truths is not the business of experimental science. The object of science, according to Kirchhoff, is to describe natural phenomena in the simplest way possible. If a theory like the atomic theory helps us to describe observed phenomena more simply and to discover new ones, let us use it by all means. But (they would say) since the existence of atoms cannot be verified directly,[3] it is really useless for scientific purposes to discuss whether the theory is true or not. Obviously, science here abandons those claims to finality which have been insisted on so strongly by the older and more orthodox school, for our simple descriptions are liable at any moment to be replaced by descriptions still more comprehensive and still more simple. It would be hard indeed to prove that any given theory has attained a maximum of simplicity in summarising the facts with which it deals.

1 "Principles of Inorganic Chemistry." Translated by A. Findlay, 1902, p. 146. (Macmillan and Co., Ltd.)

2 See Prof. James Ward's "Naturalism and Agnosticism," 2 vols., 1899.

3 "No physicist or chemist can produce a single atom separated from all its fellows and show that it possesses the elementary properties he assigns to it" (Sir A. Rücker, *loc. cit.*).

Kirchhoff's self-denying ordinance on the part of science leaves, no doubt, a wider field open to the metaphysicians. But *qui trop embrasse mal étreint;* and the limitations of scientific claims which he advocates may well strengthen science in her own proper borders.

The atomic theory has had a long and venerable history; the "solid, impenetrable" particles of Newton were originated by the Ionian philosophers in the fifth century B.C. A hundred years ago the genius of Dalton gave the theory a fresh and still unfinished career of usefulness, and whether we consider it in the light of a truth that cannot ever disappear from science, or rather as an engine serving to fashion and unite our ideas, possibly to be replaced later by an intellectual mechanism still more efficient, our debt to Dalton remains one of the greatest that the world owes to its great men.

P. J. HARTOG.

NOTES.

A SPECIAL meeting of the Physical Society will be held on Friday, June 5, at 5 p.m., at University College, when Prof. Rutherford, of Montreal, will read a paper on radioactive processes. A discussion will follow, in which it is hoped several prominent physicists will participate.

IN reply to a question asked in the House of Commons on Tuesday, Mr. Balfour stated that the Government would contribute to the funds required to send the relief ship *Morning* to the Antarctic at the end of this year, to ensure the safety of the officers and men of the *Discovery*, now ice-bound in Antarctic seas.

THE ninth quinquennial conference of the States adhering to the International Telegraph Convention was opened on Tuesday by the Postmaster-General, Mr. Austen Chamberlain, M.P. The business of the conference will go on from day to day until the end of June. Mr. J. C. Lamb, C.B., C.M.G., the principal delegate of Great Britain, was chosen president of the conference, and Mr. John Ardron and Mr. P. Benton vice-presidents.

M. HENRI BECQUEREL, Paris, and Prof. A. Righi, Bologna, were elected honorary fellows of the Physical Society of London at the last general meeting.

THE *Daily Mail* announces that Mr. Andrew Carnegie has offered to subscribe 10,000*l.* towards the erection of an experimental tank for testing ship models, as a memorial to James Watt.

MR. ANDREW CARNEGIE has offered to give 200,000*l.* for a building for the American engineering societies. It is, says *Science*, to be situated in New York City, and will provide an auditorium, a library and headquarters for five engineering societies.

THE death is announced of Prof. C. A. Bjerknes, professor of pure mathematics at the University of Christiania, at the age of seventy-eight, and of Dr. G. C. Dibbits, formerly professor of chemistry at Utrecht, at the age of sixty-four.

THE death is announced of M. Félix Worms de Romilly, a former president of the French Physical Society, who served for many years on the council, and who in addition contributed liberally towards the cost of certain publications undertaken by the Society.

THE *Bulletin de la Classe des Sciences* (Brussels) announces the death, at the age of seventy-six, of M. Charles de la Vallée Poussin, professor of mineralogy and geology of the University of Louvain, and author of important geological papers published in the *Bulletin* itself

and in the *Annales* of the geological and scientific societies of Brussels.

A REUTER message from Stockholm, dated May 22, states that the expedition which is being fitted out to relieve the Nordenskjöld Antarctic Expedition will be provided with stores for three years. It will be under the command of Captain Gylden, of the Swedish navy, who was in charge of the expedition sent to Spitsbergen in 1901 for the measurement of an arc of meridian.

A CORRESPONDENT of the *Times* states that an earthquake was widely felt in Turkish Armenia on April 29. More or less severe shocks were experienced from Van to Baiburt, on the north-west, and it is feared that the loss of life has been extensive. So far no actual details as to the effects of the earthquake seem to have been received, except some relating to the military losses at a town about 100 miles north of Erzerum.

THE annual report to the Conseil de l'Observatoire de Paris, which M. Maurice Loewy is preparing for publication, will contain an account of the recent observations made at Greenwich and Paris for the determination of the difference of longitude between the two observatories. In each observatory a French and an English astronomer made observations independently in the spring and autumn of last year, and a Paris correspondent informs us that the discussion of the two series shows no sensible difference between the French and English results. When the calculations have been completed, the results will be described in papers to be presented at the same time to the Royal Society and the Paris Academy of Sciences by Mr. Christie and M. Maurice Loewy respectively.

THE Australasian Association for the Advancement of Science will hold its next meeting at Dunedin in January, 1904, under the presidency of Prof. T. W. E. David, of Sydney University. The sections and their presidents will be as follows:—A—astronomy, mathematics, physics, and mechanics, Prof. W. H. Bragg; B—chemistry, Mr. J. Brownlie Henderson; C—geology and mineralogy, Mr. W. H. Twelvetrees; D—biology, Colonel W. V. Legge; E—geography, Prof. J. W. Gregory, F.R.S.; F—anthropology and philology, Mr. A. W. Howitt; G—(1) social and statistical science, president not yet appointed; G—(2) agriculture, Mr. J. D. Towar; H—architecture, engineering, and mining, Mr. H. Deane; I—sanitary science and hygiene, Dr. Frank Tidswell; J—mental science and education, Mr. John Shirley.

THE annual congress of the South-eastern Union of Scientific Societies will be held at Dover, June 11–13. On Thursday evening, June 11, the president-elect, Sir Henry H. Howorth, F.R.S., will deliver the annual address. The following papers will be read on June 12:—Atmospheric moisture as a factor in distribution, by Mr. A. O. Walker; experiences of leprosy in India, by Dr. Jonathan Hutchinson, F.R.S.; the diminution and disappearance of south-eastern flora and fauna within the memory of present observers, by Captain McDakin and Mr. Sydney Webb; the seedlings of geophilous plants, by Miss Ethel Sargant; the white chalk of Dover, by Dr. Arthur Rowe; a late Keltic cemetery at Harlyn Bay, by Rev. R. Ashington Bullen. On June 13 Mr. A. T. Walmisley will lecture on international communication.

THE first section of the London County Council's electrical tramways, opened a few days ago by the Prince and Princess of Wales, is of special interest because in the electrification of this tramway the conduit system has been adopted instead of the overhead trolley system, which has been almost universally installed elsewhere throughout the country. The appearance of the line is unquestionably very much superior to that of lines equipped on the overhead system, but it remains to be seen whether it will work equally well in practice; for this reason the working of the new lines will be watched with special interest during the next few years. The cost of installing the conduit system has proved much greater than that of equipping an overhead system, and it is to be hoped that some other advantages will be found to result in working in addition to the gain in appearance, as the district can hardly be said to be one of such great natural beauty that overhead lines would have spoilt it.

THE Middlesex Hospital at the beginning of this year established a complete electrical installation for electro-medical work. The equipment includes all the necessary apparatus for X-ray work, high-frequency, Faradic and galvanic treatment. There are two Finsen lamps for the treatment of lupus, and experiments are also being tried in the treatment of this disease by the Cooper Hewitt mercury vapour lamp. The greater part of the apparatus has been set up in a special temporary building. This is already being found somewhat too small for the number of patients passing through, which amounts to about three hundred a week. Two trollies fitted with apparatus and coils for treatment and radiographic work have also been equipped. It is stated that the results obtained in cases of lupus have been most satisfactory, and that the X-ray treatment of cancer is also giving promising results. The high-frequency treatment of cancer has not been found as yet to justify the claims made in its favour, but further experience and observation are required.

A *Daily Mail* correspondent at Rome states that shortly before eleven a.m. on May 22, an earthquake shock was felt throughout Italy.

ROBINS frequently build in curious places. Miss E. M. Milner sends from Stafford a photograph of a robin's nest built in a small leather handbag that was hung in an arbor near her house. Five eggs were laid and hatched in this nest.

REFERRING to the discovery of a radio-active gas in water by Prof. J. J. Thomson (April 30, p. 609), and the demonstration by Prof. Rutherford that the emanation from radium and thorium is a gaseous body, Mr. W. A. D. Rudge writes to suggest that some interesting results might be obtained from the examination of the gases withdrawn from deep mines for the purpose of ventilation. Mr. Rudge also suggests that these radio-active gases may be of the nature of metallic carbonyls, "because they are the only known metallic compounds which are gaseous to any extent at ordinary temperatures."

THE Meteorological Council has issued a notice stating that it will, as before, supply forecasts of weather during the summer months (June to September inclusive) for the benefit of agriculturists and others as was arranged last year. These forecasts are sent by telegraph at about 3h. 30m. p.m. to those who express a wish to receive them regularly, and who defray the cost of the telegrams, which will be so worded that the cost of each message will be 6*d*. for any one district, including an address of three words. This service of harvest forecasts is, in addition to the ordinary service of forecasts, prepared at 11h. a.m. and 8h. p.m. The harvest forecasts refer to the weather of the next day.

INTERNATIONAL scientific balloon ascents were made on the morning of March 5; the balloons were both manned and others equipped with recording instruments only, while

at some stations kites were used. We quote only the preliminary results of the registering balloons, as these attained the greatest altitudes. At Trappes, near Paris, a temperature of $-49^{\circ}.8$ C. was registered at 10,000 metres; the reading at starting was $9^{\circ}.6$, and an inversion of $0^{\circ}.2$ occurred at 750 metres. The balloon rose to 15,700 metres, but if readings at higher altitudes than those quoted are suspected of being vitiated by radiation, they are scrupulously rejected. At Strassburg, the temperature at starting was $6^{\circ}.3$, and the following readings were recorded:—$-59^{\circ}.1$ at 15,600 metres, $-54^{\circ}.0$ at 10,300 metres, $-51^{\circ}.5$ at 12,200 metres. A second balloon, on March 6, recorded $-62^{\circ}.1$ at 15,330 metres, $-51^{\circ}.2$ at 10,200 metres, and $-48^{\circ}.2$ at 11,300 metres. At Berlin the following temperatures were recorded:—$-57^{\circ}.0$ at 10,400 metres, $-51^{\circ}.0$ at 12,000 metres; at starting $4^{\circ}.4$. The type of weather was cyclonic over the British Isles and west of Scandinavia, and anticyclonic over south-west France and eastern Russia.

There has recently been some discussion in the columns of our contemporary *Science* as to who first made use of the word "barometer." It occurred in a paper by Boyle in the *Phil. Trans.* of 1666, and also in an anonymous article in the same journal in 1665. Our valued correspondent, Mr. A. L. Rotch, refers to the use of the word in 1665 in "The General History of the Air . . . by the Honble. Robert Boyle, Esq.," published in London in 1692. We have referred to the work and to the article in question, viz. "A Short Account of the Statical Baroscope, imparted by Mr. Boyl, March 24, 1665. In a Letter to Mr. H. Oldenburgh." As the matter may be of interest to our readers, we quote the sentence (p. 98):—"When I come to another Place, where there is a Mercurial Barometer, as well freed from Air as mine (for that must be supposed) if taking out my Scale-Instrument, it appears to weigh precisely a Drachm; and the Mercury, in the Baroscope there, stand at 29¾ Inches, we may conclude, the Gravity of the Atmosphere, not to be sensibly unequal in both those two Places, though very distant."

During the summer months of the years 1900–1902, the cutter yacht *Walwin*, belonging to Dr. R. N. Wolfenden, was engaged, under the owner's direction, in taking sea temperature observations at the surface and at various depths, and in the collection of samples of water in the channel between the Shetland and Faeroe Islands. The discussion of the observations was entrusted to Mr. H. N. Dickson, who has communicated the results in an interesting paper to the *Geographical Journal* for April. There are two opposing movements of water in the channel, from the south and from the north. The former, or north-moving currents, are of two kinds:—(*a*) drift currents caused by the winds; these are strongest during winter; and (*b*) stream currents, or the Norwegian branch of the European stream; these are strongest during summer. The south-moving currents are also of two kinds:—(*c*) water from the central and western parts of the Norwegian sea, and (*d*) water derived from the melting of ice in the Arctic regions. One of the conclusions drawn by the author is that the movements of the surface waters of the sea and the temperature of the air near the British Isles do not stand in any direct relation of cause and effect. The temperature of the surface water influences the distribution of atmospheric pressure, and will therefore affect the direction of the prevailing winds, but motion has nothing to do with this influence.

An exhibition of mounted heads of the larger mammals and other products of the chase from the German Colonies (Deutsch-Kolonial Jagd-Austellung) has lately been opened at Carlsruhe, under the patronage of the Grand Duke Frederick of Baden. More than fifty persons, who have been out in the German Colonies as officials or in quest of sport, have sent their trophies to it, and a most extensive and instructive series of specimens is the result, which no one interested in the larger game-animals should fail to see. The well-known traveller and naturalist, Oscar Neumann, has contributed the whole of his large African collection. Herr Carl Hagenbeck, of Hamburg, who has long been engaged in getting together a series of heads and horns from all parts of the world, has likewise sent the whole of them to Carlsruhe for exhibition. Amongst the latter the specimens of wild sheep, ibexes and deer from Central Asia have attracted much attention. The collection will be open to view all the summer in the building of the Jubileum Art Exhibition, at Carlsruhe.

Captain Stanley Flower, the director of the Zoological Gardens at Gizeh, near Cairo, is expected to arrive in England about the end of this month, and will bring with him a valuable contribution to the Zoological Society's menagerie. This is a male Grévy's zebra, by far the largest and finest member of the group of African striped asses. There are already two female examples of this beautiful animal in the Zoological Society's Gardens, which have been placed under the Society's care by H.M. the King, so that the acquisition of a male of the same species is eminently desirable. The male in question was obtained for the Society by Colonel Harrington, the British Resident at the capital of Abyssinia, and was brought down as far as Cairo in December last. But it was thought prudent to keep the animal in a warmer climate during the winter season, so it was arranged to deposit it at Gizeh under Captain Flower's care. It is hoped that Captain Flower will likewise be able to bring to England on the same occasion another female of the same species of zebra, also obtained for the Zoological Society by Colonel Harrington.

An important series of statistical articles dealing with the occurrence and incidence of cancer in various countries has been published in the *British Medical Journal*. The main conclusions arrived at are that cancer is prone to attack certain races, especially the Scandinavian and the different branches of the Germanic family, that it is more prevalent in districts in which beer is the staple drink, and that it tends to cause excessive mortality in regions abounding in water, and to a much more marked extent when these are covered with woods or forests.

The well-known salmon disease, since the researches of the late Prof. Huxley, has always been regarded as being caused by the attack of a fungus, the *Saprolegnia ferax*. Recently Mr. Hume Patterson has conducted a research for the Fishery Board for Scotland, and has come to the conclusion that the disease is due to vasion of the tissues of the fish by a special bacillus (*B. salmonis pestis*), which gains access through some abrasion or ulceration of the skin. When the skin of the fish is in a healthy state, the disease is apparently not contracted. The bacillus remains alive in the dead fish, which therefore prove a source of infection, and should immediately be removed and burnt as soon as they are observed.

Various explanations have been given of the cause of the phenomenon of agglutination, the aggregation of the bacteria into clumps, that occurs when an immune serum is added to a bacterial culture. A substance termed agglutinin develops in the serum as the result of immunisation (also frequently during an attack of infective disease, *e.g.* typhoid fever), which combines with some constituent in

the bacterial cell. Dr. A. E. Wright suggests that this combination alters the electrical relations of the fluid and suspended particles (bacteria) so that these then offer an appreciable resistance. The electric currents generated by the ionisation of the salts in solution would tend to drive these interposed resisting particles out of the direct line of action, and the displaced particles would all tend to find a position of rest in the angles between the intersecting lines of force, and so clumping would result. (*Lancet*, May 9, p. 1299.)

MUCH work has of late years been carried out upon the nature and physiological action of the venoms of poisonous snakes. The latest contribution to the subject is a memoir by Captain Lamb and Mr. Hanna upon the venom of Russell's viper (*Daboia Russellii*). They find that Daboia venom owes its toxic property chiefly to its action upon the blood, the rapid death which results being mainly due to extensive clotting of the blood in the blood-vessels. Heating a weak solution of the venom (0·1 per cent.) for half an hour to 73° C. completely destroys the toxicity, though a more concentrated solution (1 per cent.) may have its toxicity only lessened by this treatment. Daboia venom and cobra venom differ in two respects; cobra venom contains a toxic substance of the nature of an albumose, which acts especially upon the central nervous system, and is the essential poisonous constituent, whereas it contains no substance causing intra-vascular clotting. Daboia venom, on the other hand, contains no toxic element having an action similar to that of the toxic albumose of cobra venom. Calmette's anti-venin, which has a powerful neutralising action for cobra venom, possesses little or no such property for Daboia venom. (*Scientific Memoirs of the Government of India*, No. 3, Calcutta.)

PART i. vol. iv. of the *West Indian Bulletin* contains a complete record of the observations of atmospheric phenomena at various points on the island of Barbados during the fall of volcanic ash following the eruption of the St. Vincent Soufrière on March 22 last, together with the results of the chemical analysis of the ash by Prof. d'Albuquerque, and of the mineralogical analysis by Dr. Longfield Smith. The latter states that the minerals present were the same as those found in previous falls, but the relative proportions differed very considerably, the most striking feature, which at once distinguish the late fall from former ones, being the large amount of magnetite and hæmatite present. There was only a small proportion of glass, which was of two kinds—a clear, colourless to brown variety, enclosing microlites and often crystals of felspar, and a translucent to opaque variety, the latter often brown, owing to numerous hæmatite inclusions.

THE Imperial Department of Agriculture for the West Indies is giving some attention to the question of improving the corn yield of the islands for estate purposes. At present enormous quantities of corn have to be imported, for the islanders grow corn only as a catch crop, which is often planted at wide distances apart, and little or no attention is given to it. As a result the yield of corn averages only about ten bushels per acre, the quality grown containing 10 or 11 per cent. of protein. In a recent number of the *Agricultural News* it is stated that much better results "may be attained without the aid of elaborate chemical analyses, and with no more apparatus than a pen-knife, an observant eye, and the expenditure of a certain amount of care and time." Based upon the investigations of Prof. Hopkins, of the University of Illinois, simple instructions are given for making a chemical selection of ears of seed-corn by a simple mechanical examination of the kernels, thus enabling farmers to separate the high-protein from the low-protein seeds. It is hoped by adopting this method of corn-breeding to increase the protein yield by about 2 per cent., while the greater care devoted to the cultivation would necessarily lead to a substantial increase in the quantity of corn produced per acre.

AN interesting account of the works of the late Sir G. G. Stokes is given by Prof. W. Voigt in the *Nachrichten* of the Göttingen Academy, 1903, part i.

THE Actien Gesellschaft für Anilin Fabrikation, of Berlin, send their price list of dry plates, developers, and other requisites for photography, which they manufacture under the registered name of Agfa.

CONSIDERABLE uncertainty has prevailed as to the existence of conjugation in the Amœbæ. In the *Atti dei Lincei*, xii. 7, Signora Margherita Traube Mengarini publishes a paper on the subject. The authoress has been sufficiently fortunate to observe a process of true conjugation in *Amoeba undulans*, apart from the process of fusion observed by Zaubitzer and Maggi. This process lasts but a short time, and it ends in the complete separation of the animals, so it is difficult to study the phenomenon in its entirety.

IN connection with the debated question of the magnetic action of convection currents, MM. Crémieu and Pender have undertaken a series of experiments the results of which are summed up in the *Bulletin* of the French Physical Society. They now definitely prove that metallic surfaces turning in air, either with or without the presence of parallel armatures, produce magnetic effects agreeing to within 10 per cent. of the amounts required by the convection theory. A further mode of experimenting is described by M. Vasilesco Karpen, who produces an alternating convection current by rotating an ebonite disc charged by an alternating current.

M. LÉON GUILLET contributes some interesting notes to the *Bulletin* of the French Physical Society on the metallography of nickel steel. The steel was of three different classes, the first having the same structure as carbon steel, the second (mertensite) having the structure of tempered steel, and the third a polyhedral structure. It is found that these classes differ notably in their behaviour when subjected to tempering, heating, extreme cold, and decarburation, and M. Guillet finds a close relation between the mechanical properties of the steel and its micrographic structure.

UNDER the title of *Zeitschrift für wissenschaftliche Photographie, Photophysik und Photochemie*, a new journal has been brought out by Messrs. Ambrosius Barth, of Leipzig. The editors are Dr. E. Englisch (Stuttgart) and Prof. K. Schaum (Marburg), with whom Prof. H. Kayser (Bonn) has cooperated. The first number contains papers on Kirchhoff's laws, by F. Richarz and A. Pflüger; on the photochemistry of silver iodide, by Lüppo-Cramer; and on stereoscopic photography of microscopic objects, by W. Scheffer, the last paper being illustrated by a plate showing stereoscopic representations of a fly and other objects. A noteworthy feature is the collection of abstracts of papers dealing with physical and physiological optics, radiography, photography, and allied subjects, which are to include electricity and wireless telegraphy.

THOSE who are engaged in the teaching of elementary experimental physics will find a mine of wealth in Prof. Bohn's newly-published illustrated catalogue of instruments

and models taken from the Schäffer Museum. The late Hermann Schäffer, whose death was announced in 1900, and who held a chair of mathematics and physics at the University of Jena from 1856 onwards, devoted a large portion of his lifetime to the formation of this collection, which consists of models and instruments constructed for the express purpose of illustrating in the clearest and simplest way the elementary properties of matter, light, heat and electricity. Prof. Bohn describes about 350 apparatus out of a collection of many thousands now housed in the Zeiss Institution in Jena. A noteworthy feature of Schäffer's methods was the great use he made of glass in order that his pupils might see the complete working of the experiments.

WE have received a copy of the second number of a new paper called the *British Inventor*. The new journal contains a few brief notes on scientific novelties, but is chiefly concerned with popular and trade aspects of invention.

WE have received a copy of a catalogue of the Romanised geographical names of Korea, compiled by Prof. B. Kotô and Mr. S. Kanazawa, of the Imperial University of Tōkyō, Japan. The catalogue is published by the Tōkyō University, and should prove of great assistance to travellers in the interior of Korea.

FIVE more parts of the first annual issue of the "International Catalogue of Scientific Literature" have just been published. These newly issued volumes include the second part of vol. iv., which deals with works on physics; vol. x., mathematical and physical geography; vol. xi., mineralogy, including petrology and crystallography; vol. xii., geology; and a volume giving a list of journals with the abbreviations used in the catalogue as references.

THERE has been issued from the Government Printing Office, Washington, U.S.A., a reprint of a "Bibliography of Cooperative Cataloguing and the Printing of Catalogue Cards (1850–1902)," by Messrs. Torstein Jahr and Adam J. Strohm, which was included in the report for 1902 of the Librarian of Congress. In view of the cooperative plans of the Royal Society, the Brussels Institut international de bibliographie, and the Concilium bibliographicum at Zurich for the production of international catalogues of scientific works, the publication of this list of works should interest many European men of science.

PARTS I. AND II. of the *Transactions* of the Royal Society of Edinburgh, dealing with the work of the sessions 1900–1902, have now been published by Messrs. R. Grant and Son, of Edinburgh, and Messrs. Williams and Norgate, of London. Among the twenty contributions to the two volumes, the following may be mentioned as of wide scientific interest: Dr. Masterman's contribution to the life-histories of the cod and whiting; the second part of Sir William Turner's study of the craniology of the people of the Empire of India; Mr. Aitken's notes on the dynamics of cyclones and anticyclones; Mr. Harker's paper on ice-erosion in the Cuillin Hills, Skye; and Dr. Scott's investigation of the primary structure of certain palæozoic stems with the Dadoxylon type of wood. The reports published from time to time in our columns of the meetings of the Royal Society of Edinburgh make any detailed reference to the contents of these volumes unnecessary.

SECOND editions have been issued of Mr. M. M. Pattison Muir's translation of Dr. Robert Lüpke's "Elements of Electro-chemistry Treated Experimentally" (Messrs. H. Grevel and Co.), and of Mr. George Massee's "Text-book of Plant Diseases caused by Cryptogamic Parasites" (Messrs. Duckworth and Co.). Mr. Pattison Muir has incorporated the important changes and additions made by the author in the third German edition, and also added about a dozen new illustrations. Mr. Massee has taken the opportunity to deal in the new edition of his book with several destructive diseases which either have appeared for the first time or have developed and extended to an alarming extent since the appearance of the first issue of his work.

THE fifth edition of the "Introduction to the Study of Metallurgy," by the late Sir William Roberts-Austen, published by Messrs. C. Griffin and Co., Ltd., was fortunately completed by its distinguished author before his death, and has now made its appearance. The book has again been enlarged and improved, and in its present form is necessary to every student of metallurgy who desires to obtain a general view of his subject. Besides being one of the most readable of scientific works, it will provide Sir William Roberts-Austen's many friends with an interesting memento. The two presidential addresses delivered by the author before the members of the Iron and Steel Institute in 1899 and 1900 are printed in an appendix, and the whole volume is a token of the interest he took in the welfare of his students.

THE latest issue of the memoirs of the Société de Physique et d'Histoire Naturelle de Genève contains the president's report for the year 1902, together with a monograph by the late M. Marc Micheli on the Leguminosæ collected in the Mexican States of Michoacan and of Guerrero during 1898 and 1899 by the late M. Eugène Langlassé. The voyage of M. Langlassé had utilitarian ends in view, and his attention was especially directed to plants of interest to the horticulturist, and likely to prove important from the point of view of agriculture, rather than for their scientific interest. Notwithstanding this fact, the number of new species contained in his collection shows conclusively that many new forms will be forthcoming when the country visited by M. Langlassé is systematically explored by competent botanists. Among the 237 kinds of leguminous plants collected, M. Micheli described twenty-six as new species, and he admits one new genus. The monograph is accompanied by twenty-eight beautifully executed plates, which serve as an admirable accompaniment to what proved to be the last piece of work of the author.

IN accordance with a resolution passed at the International Geological Congress at Paris in 1900 to establish a palæontological publication to bring together illustrations and descriptions of type-fossils, an international committee was appointed to prepare a programme of the publication which is to be known as "Palæontologia Universalis." The commission will publish each type-fossil on a separate plate. It has been arranged to reproduce the original figure of the type-fossil, to give a phototypographic figure of the type itself, the original description without alterations or abbreviations, and additional observations by the authors. The two specimen plates which have reached us are excellent, and the series, when complete, should be of great service in making known rare and frequently unknown descriptions and figures of type-fossils. The assistance of numerous palæontologists has been secured, and they will prepare the plates of the type-fossils of the greatest interest in the collections in their care. Dr. von Zittel is president of the committee, and M. D. P. Œhlert is the secretary. The British members are Messrs. F. A. Bather and A. Smith Woodward. The annual subscription is 1*l.* 12*s.*, which should be sent to Messrs. William Wesley and Son, 28 Essex Street, W.C.

THE extraction of the perfume from flowers such as jasmine, tuberose, violet and cassia has long been carried out by the process of enfleurage, the blossoms being left in contact with purified lard for a few days, and then replaced by fresh blossoms. The lard is either sold as such, or the essential oil may be extracted from it by melting it under strong alcohol. As the process of enfleurage is somewhat tedious, attempts have frequently been made to extract the oil directly from the flowers by means of light petroleum, but these processes have not as a rule proved successful, and it has recently been found that a very large proportion of the perfume is actually produced for the first time in the blossoms during the time occupied by the enfleurage. An interesting illustration of this is given by Dr. Albert Hesse in a recent number of the *Berichte*, in which he states that a ton (1000 kilos.) of tuberose blossoms only yielded 66 grams of oil when extracted with light petroleum, but during enfleurage yielded 801 grams of oil to the fat in which they were embedded, whilst a further 78 grams remained in the faded blossoms and could be separated by extraction or distillation. It thus appears that eleven times as much perfume is produced during enfleurage as is originally present in the flowers, and that even after enfleurage the exhausted flowers contain more perfume than when first gathered.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Captain Lambert Larking; a Naked-footed Owlet (*Athene noctua*) from Holland, presented by Mr. R. Souper; a Common Cormorant (*Phalacrocorax carbo*), British, presented by Mr. C. F. McNiven; a Nilotic Trionyx (*Trionyx niloticus*) from West Africa, presented by Mr. Henry Reeve; a Common Chameleon (*Chamoeleon vulgaris*) from North Africa, presented by Mr. M. J. Comyn; three Suricates (*Suricata tetradactyla*) from South Africa, ten Black-spotted Lizards (*Algiroides nigro-punctatus*) from Madeira, deposited; a Thar (*Hemitragus jemlaica*), a Burrhel Wild Sheep (*Ovis burrhel*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE:—

June 3. Predicted perihelion passage of Faye's comet.
,, 15h. Mars in conjunction with moon. Mars 1° 49′ N.
8. 12h. 10m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc=0·613, of Mars =0·885.
,, 11h. Uranus in opposition to the Sun.
17. Juno 1° N. of μ Serpentis (mag. 3·6).
,, 14h. Jupiter in conjunction with the moon. Jupiter 3° 7′ S.
19. 11h. 31m. to 14h. 55m. Transit of Jupiter's Sat. IV. (Callisto).
20. 12h. 52m. Transit (egress) of Jupiter's Sat. III. (Ganymede).
22. 3. Sun Enters Gemini. Summer commences.
27 9h. 28m. to 10h. 5m. Moon occults α Cancri (mag. 4·3).
,, 13h. 36m. to 16h. 46m. Transit of Jupiter's Sat. III. (Ganymede).
,, 16h. Mercury at greatest elongation 22° 5′ W.

VARIABILITY OF NOVA GEMINORUM.—A note from Prof. E. C. Pickering which appears in No. 3868 of the *Astronomische Nachrichten* states that the light of Nova Geminorum appears to be fluctuating in a manner similar to that of Nova Persei, No. 2. During the twenty-four hours preceding the evening of May 1, it had increased by half a magnitude.

The nature and amount of these fluctuations will be seen from the following table of measures made at Harvard:—

Date.	Magnitude.	Date.	Magnitude.
April 24	... 9·37	April 29	... 9·61
,, 25	... 9·67	,, 30	... 9·76
,, 27	... 9·71	May 1	... 9·26
,, 28	... 9·81		

ORIGIN OF THE H AND K LINES OF THE SOLAR SPECTRUM.—In a paper communicated to the April number of the *American Journal of Science*, Prof. J. Trowbridge, of Harvard University, gives the results he has obtained from a series of careful experiments which he made in order to determine the constitution of the H and K lines in the solar spectrum, and also discusses the nature of reversed lines in gaseous spectra.

By a series of preliminary experiments he arrived at the conclusion that the lines which he obtained coincident with the calcium lines were not due to any calcium in the glass tubes or the terminals used in obtaining the spark, and further he argues that, even if the glass did contain calcium, the duration of the spark was not sufficiently long to raise the temperature of the glass high enough for it to produce a spectrum, whilst in obtaining his spectra he photographed a part of the spark which was far enough removed from the terminals to ensure the absence of metallic particles ejected by them.

Using quartz tubes sealed by metallic ends he obtained the reversed line at λ 4227, and also lines coincident with the solar lines 3968 and 3933, quite as strong as when a glass tube was used, whilst the other strong calcium lines towards the ultra-violet were conspicuously absent.

Prof. Trowbridge found that the spectra obtained from a highly disruptive spark discharge between electrodes of some metals do not show these lines, whilst those obtained from a similar spark between other metals, *e.g.* pure silver, platinum and iridium, do show them; he suggests that in the former case the metals are easily volatilised, and their vapours conduct the spark, whereas in the case of the latter class of metals the air conducts the discharge because no metallic vapours are produced, and therefore it is some gaseous constituent of the atmosphere which produces the lines in question. For similar reasons he believes that some lines at present attributed to silicon—another highly refractive substance—are possibly atmospheric.

From these observations Prof. Trowbridge arrives at the following conclusions:—"At the basis of the great H.H lines of the solar spectrum there are strong gaseous lines which I believe to be oxygen lines. The reversed lines which apparently coincide with certain calcium lines are not due to calcium but are gaseous." Reproductions of four spectrograms, which accompany the article, illustrate the reasons for these conclusions.

THE LEEDS ASTRONOMICAL SOCIETY.—The tenth annual issue of the *Journal and Transactions* of this Society contains a series of useful papers which were communicated to the Society by its members during 1902. Amongst others there are papers on "Parallax," "Velocities, Paths and Eclipses in the Solar System" (illustrated by diagrams of the various orbits), "The Age of the Earth," "Brightness and Definition," and "The Year's Observations" (which were in the most part observations of Jovian phenomena), all of which should prove of value and interest to amateur astronomers.

The *Journal* concludes with a collection of the papers and letters communicated to other journals by the members of this Society during 1902.

THE ADVANCEMENT OF PHOTOGRAPHY.

AT the recent meeting of the Royal Photographic Society held to celebrate its jubilee, the president, Sir William Abney, K.C.B., F.R.S., suggested, in an address of which an abridgment is given below, that the Society should further mark the close of the first fifty years of its existence by establishing laboratories and suitable accommodation for the carrying out of photographic researches. A donation of 100*l.* has already been promised, on condition that 900*l.* more is raised for this purpose. The establishment of such facilities is highly desirable, for, excluding the work of a few whose names may be counted on the fingers of one

hand, and that done by our manufacturers, which has, so far, succeeded in keeping them in the van of progress, investigations into the underlying facts of photography may be said to be non-existent in this country. A thousand pounds is a very modest sum to ask for, though no doubt it will serve to make a beginning. We hope that before very long this sum will be multiplied many times over, and that the science of photography will begin to take its proper place, instead of being regarded, as it is too often at present, as a very minor detail of a considerable industry, and an empirical art. The following remarks are from Sir William Abney's address:—

Looking back to the first day of this Society's existence, one is forcibly reminded of the advances that have been made, not only in the science, but in the art of photography, but these advances I think might have been more rapid. A very brief comparison of the processes existing now and fifty years ago will show what I mean. Paper processes, founded on the original process of Fox Talbot, were well to the fore fifty years ago, although in 1851 Scott Archer had shown to the world the practicability of taking photographs on glass by means of collodion. In that same year, when the First International Exhibition was held, calotype, Daguerreotype, and collodion processes were all worked commercially, and photographs of the interior of the Palace by all three processes are in being to-day.

At the present time it may be said that for all practical purposes the gelatine process for taking negatives has complete possession of the field, and ousted all processes which have led up to it. Negatives fifty years ago were impressions only given by the violet and blue rays existing in white light, and the resulting prints are such as would be seen by a person colour blind to the red and the green, whilst now it is not uncommon for the photograph to be made to coincide with visual impression of an ordinary eye.

There seems but little doubt that the photographic image remains of the same nature now as it was then, and whatever may have been the action of light then, so it is now, but the necessary exposure to obtain a properly developable image was at least sixty-fold more than is required for our present process, even when the collodion process was employed, where every condition remained the same except the sensitive surfaces themselves. With the Daguerreotype process perhaps we should have required ten times more than for the collodion, though we know of instantaneous work being done even with that process. For open air portraiture, the early Daguerreotypist required half an hour in bright sunshine, whilst the modern amateur will be content with a second or a fraction of a second in the same circumstances. A question one naturally asks is, What causes the difference? So far as I am aware, this question has not been fully answered, and yet it might have been had serious experiment been undertaken regarding it.

From a theoretical standpoint there are three things that have to be taken into account:—1st, the sensitiveness of the silver salt itself; 2nd, the mediums in which it is placed; and 3rd, the means of development. We have some clue to the last two. Beginning with the last first, those who practised Talbotype or the wet collodion processes know that in both of them the developing solution was an acid solution reduced from nitrate of silver, which was on the surface of the plate or paper, to the metallic state, and that there was some attractive force which caused the metallic silver to adhere to and crystallise on particles of sensitive salt which had been acted upon by light. In the gelatine process we know that development is with alkaline solution, and that the image is built up from the very molecules themselves that have been acted upon, the sensitive salt itself being reduced to metallic silver. Why should development be effected more easily in the one case than in the other? In the case of the acid development the distance of the particles of reduced silver from the molecules altered by light are far greater than they are when the material of the plate is attacked, and consequently a smaller attractive force, due to fewer molecules being altered in the latter case, is efficacious in producing a silver image than in the first case where the depositing silver has a considerable distance into which the attractive force has to be exercised. This might be an explanation. Or, again, it may be shown that a gelatine film, being a kind of filter to the developing solution, acts as a regulator in allowing the active alkaline solution to reach the particles of silver salt, and that this regulated supply would attack the molecules on which light had done part of the work of decomposition, and reached the remaining part most readily to be finished and so on, and that very little external retarding influence was necessary. But now, what is to be said regarding the increased instability of the sensitive salt? This is a question not yet investigated, but it is from such an investigation that increased rapidity is to be looked for.

But it is one thing to say what proof is required, and it is another to have the opportunity of making such proofs, and I should urge that it is part of the duty and functions of the Royal Photographic Society to lead the way in placing such means at the disposal of its members and others as will enable any of them who have the capacity to experiment in this and in any other directions which will lead to a theoretical knowledge of the action of light. It must not be forgotten that there are a great many more men with minds trained to scientific research now than formerly. There are plenty of would-be capable workers who cannot afford a laboratory of their own, and what I should wish to see in this our jubilee year is the commencement of the formation of a research laboratory adapted to the needs of the scientific workers.

One branch of photographic science is the optical, and in it we have an example of what laboratory and experimental research can do when workers are trained in scientific methods. Not many years ago the optician was challenged to increase rapidity of exposure by increased rapidity of lens. Nobly and rapidly he has responded; the advent of Jena glass enabled him to comply with the demand, and we have been getting definition of image with ratio of aperture to focal length which would have been deemed impossible not very many years ago.

I do not believe a laboratory would be an expensive matter to start. What I do advocate is to have all essentials of all instruments of first-class workmanship, and to leave the adaptation of any instrument from one special work to that of another to the worker. Hence, if my views are carried out, the initial expenses will not be so great as might be supposed. Space is the foundation of all research in photography, and that is what the Royal Photographic Society can supply, and then comes the provision of the apparatus necessary to use in such space.

I have heard that one generous man will give 100*l.* to the laboratory if 900*l.* more are raised. The 1000*l.* would go a very long way towards what we want to start with, and I hope the members of the Society will resolve to give substantial help in raising this 900*l.* The jubilee of the Society should be marked by some important piece of work, and no bigger one and more requisite is, to my mind, to be found than starting such a help to the advancement of photography.

RADIO-ACTIVE GAS FROM TAP-WATER.[1]

WHEN Cambridge tap-water is boiled the air given off is mixed with a radio-active gas. The existence of this gas is easily demonstrated by electrical means, for if the air expelled by prolonged boiling from about 10 litres of water is introduced into a closed vessel the volume of which is about 600 c.c., the amount of ionisation in the vessel (as measured by the saturation current) is increased five or six times. When the water has once been well boiled the gas expelled on any subsequent re-boiling is not appreciably radio-active. The gas can also be extracted from water at the temperature of the room by vigorously bubbling air through it; the air as it bubbles through the water gets mixed with the radio-active gas and carries it along with it. When water which has been treated in this way is boiled, no radio-active gas is given out, nor is the gas given off when air is bubbled through water which has been well boiled.

The gas extracted in this way from the water retains its

[1] Paper read before the Cambridge Philosophical Society on May 4 by Prof. Thomson, F.R.S.

radio-active properties after bubbling through strong sulphuric acid, or caustic potash after passing over red-hot copper, or through a narrow platinum tube kept at a white heat; it does not seem appreciably affected when sparks are passed through it.

The gas can diffuse through a porous plate, and by comparing its rate of diffusion with that of CO_2 through the same plate, its density can be determined by Graham's law; preliminary measurements of this kind indicate that two different gases are present, of which one has a density about twice, the other between six and seven times that of CO_2. The gas obtained by boiling the water always diffused faster than that procured by bubbling air through the water; it seems possible that in the latter case the gas may get loaded with water-vapour to a greater extent than in the former.

A negatively electrified surface exposed to the gas becomes radio-active, the induced radio-activity dying away to half its value in about forty-five minutes. Mr. Adams has shown that a positively electrified surface also becomes radio-active when exposed to the gas, though to a smaller extent than if it had been negatively electrified; an unelectrified surface does not become radio-active. In this respect the gas differs from the emanation from radium, which, according to Rutherford, produces much more induced radio-activity in an unelectrified surface than in a positively electrified one.

The rate of diffusion through a porous plate of the gas obtained by bubbling air through distilled water containing a trace of radium is not the same as that of the gas got by bubbling through tap-water.

If the gas is confined in a closed space its radio-activity slowly diminishes. Mr. Adams found that the gas contained in a vessel of about 300 c.c. capacity lost when not exposed to an electric field about 5 per cent. of its activity in twenty-four hours; under a strong electric field the rate of loss was doubled. Water drawn from the tap and left exposed in a bucket for a fortnight gave off very little of the gas when subsequently boiled. I have not found any of the gas in any of the numerous samples of rain and surface water which I have tested.

Prof. Dewar (to whom I am greatly indebted for assistance and advice) was kind enough to subject the gas obtained by boiling the water to treatment by liquid air. Two samples were treated: one, containing about 80 litres of gas, obtained from the coppers of the Star Brewery, Cambridge, by the kindness of Mr. Armstrong (to whom I wish to express my thanks), was passed slowly through a bath of liquid air, and samples of the emergent gas collected; this on testing was found to have no radio-activity, though it was strongly radio-active before passing through the liquid air; it is evident, therefore, that at the temperature of liquid air the radio-active gas is frozen out. The other sample, of 20 litres, prepared in the laboratory was actually liquefied; the liquid was then allowed to boil away, the gas coming off at the commencement of boiling was collected, and also that coming off when the liquid had all but boiled away. On testing the samples for radio-activity the former was found to be slightly radio-active, but not nearly so much so as before liquefaction, while the second was extraordinarily radio-active, its activity being quite thirty times that of the original gas, thus showing, as we should expect from its great density, that the radio-active gas is much more easily liquefied than air.

The liquid obtained in the preceding experiment had a very strong smell of coal-gas. I must again express my thanks to Prof. Dewar and Mr. Lennox for their kindness in making these experiments.

A discharge tube was filled with strongly radio-active gas obtained as above, and the spectrum was most kindly investigated by Mr. Newall, who photographed it and measured the lines; no new lines were, however, discovered, the lines present being mainly those due to hydrocarbons.

I add a list of the various specimens of water I have examined; yes, means that the water contains the gas; no, that it does not.

Cambridge tap-water (yes). Rain water (no). Water from ditch round Botanical Garden (no). Water from Trinity College well, on the Madingley Road (yes). Water from artesian well in Mr. Whetham's garden, Chaucer Road (yes). Water from shallow well in same garden (no). Water from well at Star Brewery (yes). Artesian well in Trinity Hall Cricket Ground (yes). Artesian well at Girton (yes). Ely Town's water (yes). Birmingham Town's water (yes). Ipswich Town's water (yes).

In concluding this preliminary account I have much pleasure in thanking my assistant, Mr. E. Everett, for his help in this investigation.

GEOGRAPHICAL RESEARCH.

IN the course of his presidential address at the recent anniversary meeting of the Royal Geographical Society Sir Clements Markham, K.C.B., F.R.S., outlined a scheme, which is shortly to be put in operation by the Society, for the purpose of encouraging geographical research. The plan to be tried is the outcome of the afternoon meetings of the Society, started in 1894, for the reading and discussion of strictly scientific or technical papers. It is hoped that by the plan outlined in the subjoined extract from the president's address, the value of the afternoon meetings will be increased, and the scientific side of geography will be developed.

A permanent committee has been appointed to deal with this department of the work of the Society, to be called the "Research Committee." It will consist of those Fellows, taken from the List of Referees (which includes Fellows who have read papers, published books, or are known to have a special knowledge of any department of geography), who are most interested in, and best qualified to deal with, the subjects which are embraced in geographical research, as distinguished from exploration, in all its numerous branches. The committee will meet for the discussion of such results of investigation as may be brought before it; and the Council may be able to set apart a moderate sum each year for the purpose of encouraging such researches among the younger geographical aspirants.

Among the numerous lines that research may take, the following have been suggested:—

New methods of surveying, mapping, or computing.

Discussion of a definite problem of geomorphology (*e.g.* analysis of a river system or a coast-line).

Discussion of a definite problem of hydrography (*e.g.* circulation of water in a restricted sea area).

Discussion of a definite problem of meteorology (*e.g.* modifications of general weather conditions by local features).

Regional studies (*e.g.* synthesis of the geography of a county or of a natural unit such as the Fens).

Investigation of distribution (*e.g.* of some crop in relation to natural facilities and access to markets; of former forests in relation to existing boundaries; of village and town sites in a district).

Mapping of distribution of plant associations in a given area, or of a human disease in relation to climate and soil.

History of the map of some country (*e.g.* the British Isles).

Investigation of evidence of physical changes within historical times (*e.g.* the British coasts; the desiccation of continents).

Discussion of the relation of land forms to military movements in a selected area, or a chosen campaign.

Discussion of the relation of land forms to the distribution of man; to the distribution of animals in any area.

Geographical conditions affecting the development and colonisation of any given region.

Complete investigations from the geographical standpoint of a limited area of unexplored or partially explored territory.

There is still ample room for exploration and expeditions of discovery. We have scarcely yet laid down the great lines of the world's geography, and there is work for generations to come in filling in the details, though future exploration must become more and more exact and scientific in its characters. But we ought also to encourage research, for which exploration furnishes the raw material. By the plan now in contemplation, we shall develop the purposes of the List of Referees by constituting the Research Committee; and we shall develop further the object of the afternoon meetings by promoting research, the results of which will place the meetings on a more assured and regular system, by creating the necessity for their being more frequent and at fixed intervals.

NATURAL HISTORY NOTES.

WE learn from a contemporary that Mrs. Anderson has recently presented to the British Museum the whole of the zoological collections of her late husband, Dr. John Anderson. The great value of this collection is that it comprises all the original specimens on which Dr. Anderson based his great work on the mammals of Egypt. It also includes a collection made by Mr. T. Bent in the Hadramaut district of Arabia, and many specimens procured by Mr. H. F. Witherby in the Eastern Sudan—areas of which the fauna was but imperfectly represented in the Museum.

Visitors to the Natural History Museum will not fail to notice the fine new pair of giraffes from East Central Africa which have just been placed on the top of the flight of steps to the right of the Darwin statue. They replace a battered specimen which has been on exhibition since 1842. The male is presented by Mr. Rothschild and the female by Captain Powell-Cotton; both are mounted by Rowland Ward.

Bad Latin, as exemplified in scientific names, is, according to Prof. Cockerell (*Popular Science Monthly* for December, 1902), an evidence of too much narrowness and too little general culture among American naturalists. As regards the amount of zoological work done by the latter, it has been estimated that this should be about one-seventh of that of the whole world, and judging from the "Zoological Record," this estimate appears to be somewhat exceeded by the reality. This, however, according to the author, represents only a fraction of the work awaiting to be done if only the number of labourers were sufficient. "The Making of Biologists" forms the title of another article by the same author in the April number of the aforesaid serial, in which it is urged that, although naturalists are undoubtedly "born" rather than "made," yet that many are deterred by adverse circumstances from embarking on the career most suited to their abilities.

An English translation, by Mr. W. H. Clifford, of two memorials presented respectively in 1895 and 1896 to the Governor and Legislature of Para by Dr. H. Goeldi, directing attention to the destruction of white herons (egrets) and scarlet ibises on the Lower Amazon, has been recently published at Para. Whether protective legislation has been the result of these appeals is not stated, but from the details of the slaughter it is quite evident that such protection is urgently needed. In an appendix the author directs attention to the possibilities of egret-farming, and states that this has been established with successful results in Tunis. Egret-plumes are worth more than their weight in gold, and the profits from a "farm" of this nature, where the feathers are cut from the birds at the proper season, ought to be very large.

In the May number of *The Field Naturalists' Quarterly* the editor directs attention to the great increase in the membership of field clubs and societies, and the multiplication of such institutions all over the country, as satisfactory proof of the awakening of interest in natural history. Among the articles in this number are one, by the Rev. G. C. Bateman, on newts in spring, and a second, by Mr. J. R. B. Masefield, on the white cattle of Chartley, Staffordshire, both illustrated. In the latter the author adopts the view that British white park cattle are the descendants of white sacrificial cattle introduced by the Romans, ignoring the close relationship between the Chillingham herd and the old Pembroke breed so strongly insisted on in Low's "British Domesticated Animals." Apparently he has not visited the domesticated series in the Natural History Museum, or, at all events, has not read the descriptive labels.

Unusual interest attaches to an article by Prof. G. H. Parker on the hearing of fishes in the March number of the *American Naturalist*. After mentioning that the sense of hearing is restricted to a small number of animal groups—notably insects and vertebrates—and is consequently a special development, the author refers to recent investigations which have been thought to prove that the ear of fishes is not connected with the auditory function. This view he believes to be incorrect, and he is convinced that fishes do hear sound-waves communicated through water. The intimate connection between sound and touch is strongly insisted upon, and it is shown that fishes—and, to a certain extent, amphibians—exhibit in a marked degree the connection between the tactile and auditory senses by means of the lateral line system. The three sets of sense-organs under consideration—namely, the skin, the lateral line, and the ear—"may be regarded as having slightly different kinds of stimuli; the skin being affected by surface-waves and currents; the lateral line organs by slight inaudible movements of the whole mass of water; and the ears by the still more delicate vibrations of water particles, sound. . . . Hearing, then, is a most delicate form of touching, and the organ of hearing has developed late in the animal series because its processes are not original, but are derived from those of the more primitive sense, touch."

Indian Museum Notes, as exemplified by vol. v. No. 3, maintains its high reputation as a chronicle of the economic entomology of the Indian Empire, this part containing five original communications from writers who are not members of the museum staff, and an important series of notes by the latter. In the first category Mr. E. P. Stebbing discusses the insect pests of the sugar-cane, while among the second reference may be made to investigations which have been undertaken in connection with insects found in drinking water. It appears that in December, 1900, the filtering beds of the Calcutta water-supply were swarming with a dipterous larva, which on examination proved to belong to the midge *Chironomus cubiculorum*, while in the following year the lake in the city of Colombo, Ceylon, was found to be so infested with the larva of a member of the same genus as to be dangerous to health. Special means for exterminating this "lake-fly" are suggested by the Government entomologist.

We learn from the April number of its official organ, the *Emu*, that the Australian Ornithologists' Union has successfully completed the first year of its existence, and that its work is steadily progressing. The excellence of its journal speaks for itself, and it may be regarded as a proof of its success that the present part contains a beautiful coloured plate, by H. Gronvöld, of blue wrens (Malurus). Perhaps the most noteworthy feature of the work of the Australian O. U. relates to the protection of indigenous birds, and the prevention of the trade in so-called "osprey" plumes. It is most satisfactory to learn that action has been taken for the better protection of the colonies of egrets in Victoria, which were so ruthlessly attacked for the sake of their plumes, with the result that the Government has decided to protect them throughout the year. Suggestions have been forwarded to the Government of Queensland with regard to the advisability of reserving certain islands for the peculiar Torres Strait or nutmeg pigeon, and efforts have been made to secure one of the Victorian lakes as a breeding-reserve for wild-fowl. The Tasmanian Government has also been approached with a view of preventing the wholesale destruction of the eggs of the Cape Barren geese breeding in certain islands of Bass Strait, since it is feared that the species is in danger of extermination. Action has likewise been taken to ensure the protection of the colonies of petrels, or "mutton-birds," breeding on Phillip Island.

"Os Mosquitos no Pará" forms the title of a pamphlet by Dr. E. Goeldi, recently issued by the Government Press of Para.

To the *Journal* of the Asiatic Society of Bengal (vol. lxxi. No. 2) Mr. K. B. Sanyal contributes some observations on the habits of the orang-utan in captivity.

We have received the report of the Rugby School Natural History Society for 1902, which contains a prize essay on the Tertiary rocks of Hampshire, by Mr. H. A. Ormerod, and shows that the Society continues to prosper.

In the *Boletin* of the Agricultural Commission on Parasites of Mexico (vol. i. No. 8), Prof. T. D. A. Cockerell describes a new scale-insect (*Neolecanium herrerae*) infesting agave; while in the February number of *Psyche* the same writer records several new races of various species of the same group belonging to the genus Eulecanium.

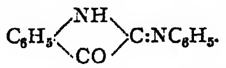
The *Boletim* of the Para Museum contains, among other papers, a list of the birds of Amazonia, extracted from the British Museum Catalogue, and a descriptive synopsis of the lizards of Brazil, both by Dr. E. Goeldi. Botanists will be interested in a paper on the "rubber-trees" of Amazonia, by Dr. J. Huber, as well as in a fifth instalment of the same author's account of the Amazonian flora.

A NEW SYNTHESIS OF INDIGO.

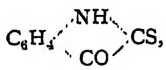
An important new synthesis of indigo is described by Dr. T. Sandmeyer in the April number of the *Zeitschrift für Farben- und Textil-Chemie*. The starting point for the synthesis is thiocarbanilid, $CS(NH.C_6H_5)_2$, which is converted in one operation by the simultaneous action of white lead and potassium cyanide into the hydrocyanide, $C_6H_5.N:C(CN).NH.C_6H_5$, of carbodiphenylimide. This compound is changed by the action of yellow ammonium sulphide into the thioamide,

$$C_6H_5.N:C(CS.NH_2).NH.C_6H_5,$$

which, when stirred into warm sulphuric acid, undergoes condensation, and yields an α-isatinanilide,



The anilide is converted directly into indigo when dissolved in alcohol and reduced with ammonium sulphide, but the indigo separates in glistening crystals which cannot easily be reduced by the ordinary methods, and so is unsuitable for commercial use. A better method, and one which renders it unnecessary to separate the isatinanilide from the sulphuric acid used in its preparation, consists in allowing the acid solution to flow into ice-water simultaneously with a solution of sodium sulphide, when the anilide is converted into thioisatin,



which is thrown down as a bulky precipitate. In order to prepare the indigo it is now only necessary to make the precipitate into a thin paste and mix it with a little alkali, when the thioisatin rapidly decomposes into indigo and sulphur. The sulphur is removed by extracting with carbon disulphide, and the indigo is left in the form of light, dark-blue blocks, which readily crumble when rubbed between the fingers, and can be made into a uniform paste which is easily reduced to indigo-white. The patents are held and are being worked by J. R. Geigny, of Basle, and the process may prove to be a formidable rival not only to natural indigo, but also to the synthetical process employed by the Badische Anilin- und Soda-Fabrik.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 249th meeting of the Junior Scientific Club was held on May 20. Mr. H. S. Souttar gave an exhibit of an automatic method of drawing capillary tubes intended for use in the capillary electrometer. Mr. S. A. Ionides read a paper on "Mining in Cornwall," in which he gave an account of the methods employed for raising and washing the tin ores.

CAMBRIDGE.—Mr. Andrew Graham, who has for nearly forty years held the office of chief assistant at the observatory, and is known to astronomers as the discoverer of *Metis*, is retiring at the age of eighty-eight. It is proposed to assign him a pension of 200*l*. a year.

The use of the Senate House has been granted to the local committee of the British Association for the meeting to be held in Cambridge next year.

LORD KELVIN and Lord Lister are to receive the honorary degrees of doctor of science from the University of Wales next November.

MR. W. M. CHILDS, vice-principal of University College, Reading, has been elected principal of the College in succession to Mr. H. J. Mackinder, who resigns office in September next.

IT is stated by the *Electrician* that a donation of nearly 40,000*l*. has been promised by Lord Iveagh to Trinity College, Dublin, with the object of building and equipping scientific laboratories.

THE Liverpool University Bill was, on Tuesday, reported for third reading by Lord Morley, Chairman of Committees of the House of Lords. The object of the Bill is to separate University College, Liverpool, from the Victoria University, and to merge it into the University of Liverpool.

THE annual report of the Royal Agricultural Society, which was adopted at the general meeting held on May 22, states that with the view of bringing before the public the general characteristics of the teaching now provided at agricultural colleges, and of directing attention to the Society's own share in this work as a national examining body, the council has decided to organise an agricultural education exhibition as a new feature of its annual show.

IN his recent paper read at a meeting of the Society of Arts Mr. G. T. Morrison gave a clear and useful account of the modern methods of construction of maps and charts. His descriptions of orthographic, stereographic, Mercator's, gnomonic and elliptical projections should prove of great assistance to teachers who wish to explain the methods employed to make maps, which either give good general ideas of the appearance of the whole or of parts of the earth, or retain some one property of the sphere at the expense of disregarding the others. Mr. Morrison thinks that for the purpose of teaching geography a projection based, not on any distinct mathematical rule, but on a system of compromise, is on the whole the best—one, for example, on which the meridians and parallels are spaced at equal distances throughout.

ARRANGEMENTS have been made for an allied colonial universities dinner and conference to be held early in July. The conference will be held on July 9 at the rooms of the Royal Society, Burlington House (by permission of the president), to discuss the question of the coordination of university education throughout the King's dominions, and the development of post-graduate courses in applied science. It is expected that an Imperial council will be formed to deal permanently with these interests. The dinner will be held on Friday, July 10, at the Hotel Cecil. The Lord Chancellor and other statesmen, many high public officials, representatives of colleges and universities in the United Kingdom and the colonies, and several distinguished men of science are expected to be present. Graduates and undergraduates of colonial universities wishing to attend the dinner, or to take part in the conference, are requested to write as soon as possible to Mr. C. Kinloch Cooke, hon. sec., 3 Mount Street, London, W.

THE annual catalogue, 1902–3, of the Massachusetts Institute of Technology at Boston gives very full particulars of the numerous courses of instruction in connection with the institute, a clear plan of the extensive buildings, a register of graduates, and other interesting details. The tuition fee for regular students is 50*l*. per annum, for half a year or any shorter period the fee is 30*l*. Special students pay, in general, the full fee; but when a few branches only are pursued and the time required for instruction is limited, applications for a reduction in the fees are considered. Regular students whose financial necessities are such as to prevent their continuance at the institute are encouraged to apply for aid to the scholarship committee of the faculty. Students may conveniently live in any of the nearer cities or towns, since the hours of the institute are from 9 to 5. The cost of board and rooms in Boston and the neighbouring towns need not exceed from thirty shillings to two pounds a week. The cost of books and material varies from five to seven pounds a year.

THE second clause of the London Education Bill, referring to the constitution of the education committee was withdrawn by the Government on Monday. In its original form the Bill provided for the appointment of thirty-one representatives of the borough councils upon the committee. This number was reduced to twelve in Committee of the House of Commons last week, but the compromise pleased nobody, so the whole clause, with its restrictions upon the local authority with regard to the constitution of the Education Committee, has been omitted from the Bill. By this action the London County Council, so far as the constitution of its education committee is concerned, is placed in precisely the same position as other local authorities brought into being by the Act of last year. The Council will frame a scheme for itself, just as other county councils have done, or are doing, and under the same conditions.

On Tuesday the Bill passed through Committee, but the third clause was greatly modified. In its altered form the clause provides for a body or bodies of management in each borough, constituted so as to include one-fourth members nominated by the County Council, and three-fourths by the borough council. The measure, as passed, does not include the clause giving the borough councils the power of appointing and dismissing teachers.

SCIENTIFIC SERIALS.

Transactions of the American Mathematical Society, vol. iv. No. 2 (April).—G. H. Darwin, approximate determination of the form of Maclaurin's spheroid.—H. S. White, on twisted cubics that have a directrix.—L. Heffter, line-integrals in n-dimensional space.—E. Kasner, the generalised Beltrami problem concerning geodesic representation.—G. A. Miller, on the holomorph of a cyclic group.—J. L. Coolidge, quadric surfaces in hyperbolic space.—A. Loewy, on the reducibility of real groups of linear homogeneous substitutions.—W. B. Ford, on the possibility of differentiating term by term the developments of an arbitrary function of one real variable in terms of Bessel functions.—E. J. Wilczynski, on a certain congruence associated with a given ruled surface.—J. Westlund, on the class-number of the cyclotomic field $k(e^{2\pi i/p^n})$.

Bulletin of the American Mathematical Society (2) vol. ix. No. 8 (May).—E. H. Moore, presidential address on the foundations of mathematics.—C. J. Keyser, concerning the axiom of infinity and mathematical induction.—E. R. Hedrick, review of R. Fricke's treatise on the differential and integral calculus.

SOCIETIES AND ACADEMIES.

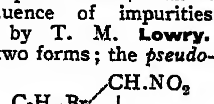
LONDON.

Royal Society, May 7.—"Experiments in Hybridisation, with Special Reference to the Effect of Conditions on Dominance." By L. **Doncaster**, B.A., King's College, Cambridge. Communicated by Dr. S. F. Harmer, F.R.S.

Describes experiments on hybrid Echinoid larvæ, made to determine whether the dominance of a character is influenced by the condition of the genital cells at the time of fertilisation. It is concluded that there is no evidence that this is the case, and that the seasonal changes observed in the larvæ are due to difference in temperature.

May 14.—"A New Class of Organo-Tin Compounds containing Halogens." By William J. **Pope**, F.R.S., Professor of Chemistry, Municipal School, Manchester, and Stanley J. **Peachey**.

Chemical Society, May 7.—Prof. H. McLeod, F.R.S., vice-president, in the chair.—It was announced that the council at its meeting that day had awarded the Longstaff medal to Prof. W. J. **Pope**, F.R.S., for his researches on the stereochemistry of compounds of elements other than carbon.—The following papers were read:—The action of ammonia and organic bases on ethyl esters of olefinedicarboxylic and olefine-β-ketocarboxylic acids, part ii., by S. **Ruhemann**.—Spontaneous decomposition of nitrocamphor, by T. M. **Lowry**. A quantity of nitrocamphor, prepared in 1898 and purified by recrystallising once from alcohol, was found to have undergone spontaneous change into a sesquicamphorylhydroxylamine, identical with that prepared from camphoryl chloride and camphoryloxime.—β-Bromo-α'-nitrocamphor- and β- and π-bromocamphoryloximes. The influence of impurities in conditioning isomeric change, by T. M. **Lowry**. β-Bromo-α'-nitrocamphor exists in two forms; the *pseudo*-form,



separates from solutions of the nitro-compound in benzene or ethyl acetate. The normal form was not isolated. A mixture of the two forms, obtained by crystallising from hot alcohol or acetic acid, softened at 100°, melted without decomposition at about 114°, and remelted sharply at 100°; the latter is therefore the temperature at which the solid *pseudo*-form is in stable equilibrium with the liquid mixture. Freshly prepared solutions of β-bromo-α'-nitrocamphor exhibit the phenomenon of mutarotation. A solution in benzene of the *pseudo*-form is at first almost inactive, but in the course of two or three days the specific rotatory power becomes constant and equal to $-80°$. The change of rotatory power is not spontaneous, but is conditioned by the presence of traces of impurity. This fact shows that, even when both isomerides are present in solution, equilibrium between them is only established in presence of a trace of a catalytic agent, probably an alkali. These phenomena are closely analogous to Baker's observations on the union of hydrogen and oxygen, and are directly opposed to Laar's hypothesis of "tautomerism."—The electrolytic reduction of pheno- and naphtho-morpholones, by F. H. **Lees** and F. **Shedden**. Attempts were made by electrolytically reducing aromatic morpholones in sulphuric acid solution to produce aromatic morpholines possessing physiological properties similar to those of morphine; the morpholone ring, however, usually undergoes secondary decomposition.—The coloured constituents of *Butea frondosa*, by E. G. **Hill**. The dried and fresh flowers of *Butea frondosa*, used in India for the preparation of a somewhat fugitive yellow dye, contain fisetin and different anhydrides of a tannic acid.—Butein. A preliminary notice by (the late) J. J. **Hummel** and A. G. **Perkin**. Butein, the colouring matter of the flowers of *B. frondosa*, described by Hummel and Cavallo in 1894, probably exists in two modifications which, on fusion with alkali, give resorcinol and protocatechuic acid. The tinctorial properties of butein closely resemble those of benzylideneanhydroglycogallol, to which it is possibly allied.—The relative affinities of polybasic acids, by H. M. **Dawson**.—The chemical dynamics of the reactions between chlorine and benzene under the influence of different catalytic agents and of light, by A. **Slator**. With a large excess of the hydrocarbon, the relative amounts formed of the two chief products chlorobenzene and benzene hexachloride depend on the conditions of the experiment. The velocity of these reactions, especially under the influence of different catalytic agents, has been measured under various conditions. Under the influence of light without catalysts, the addition reaction alone occurs; under conditions of equal illumination, the velocity of this change is found to be proportional to the square of the chlorine concentration.—The diazo-reaction in the diphenyl series. Part i. On dianisidine and 3:3'-dichlorobenzidine, by J. C. **Cain**. On heating aqueous solutions of the diazonium salts prepared from dianisidine and 3:3'-dichlorobenzidine, dark-coloured, insoluble, infusible compounds which appear to be quinones are obtained instead of the expected dihydroxy-derivatives.

Linnean Society, April 16.—Rev. T. R. R. Stebbing, vice-president, in the chair.—Dr. G. **Henderson** exhibited a coloured sketch of a withered leaf of *Quercus incana*, Roxb., and of slugs found amongst the dead leaves. The drawing of the mollusc and leaf was to show their strange resemblance in colour and outline. These slugs are common at Dalhousie in the Punjab, on ground which is always covered with these withered leaves. A few black slugs were to be found with the light-brown specimens, and whilst the latter escaped the notice of birds, the former were taken.—On some points in connection with the ordinary development of Vaucheria resting-spores, by Dr. H. C. **Bastian**, F.R.S. In 1891 the author had some spores of Vaucheria under observation in a bottle loosely covered with a screw-cap, and after a few weeks these spores were found to be germinating and emitting filaments. In 1902 the experiments were repeated on *Vaucheria racemosa*; material was kept in a shallow dish, and a few days later the spores were transferred to a stoppered bottle; another portion was put into a tumbler, loosely covered to exclude dust. Within seven weeks the bottled specimens germinated, a process which did not take place in those in the tumbler for some time later. Special attention was drawn to the pigment-granules, to be regarded as refuse-products left over during the molecular transformation that the spore has undergone in becoming decolorised; they are heaps of fine granules, without any bounding membrane. These pigment-heaps pass into the filament as spheres with a sharply-defined outline, or else press together in compressed forms. Slight to-and-fro movements were detected in them. One pigment sphere

was seen to be encysted, outside the filament from which it had been liberated. These forms resemble Amœbæ or the simplest form of Actinophrys, but seem to be so heavily charged with indigestible matter as to have but a slender chance of further development.—On the labial and maxillary palpi in Diptera, by Mr. **Wesché.** The author set out to homologise the mouth-parts of Diptera with the typical insect mouth-part, and stated that in the Muscidæ the mandibles are embedded in the dorsal side of the labium. The maxillary palpi, galæ, and laciniæ are aborted, but the cardines and stipes remain; the latter parts bear minute rudiments of the maxillary palpi. The palpi present are labial. In the Syrphidæ and Empidæ the mandibles are similarly placed, but the maxillæ are represented by the laciniæ, the *palpi*, cardines, stipes, and palpifers. The labial palpi are aborted. The author formulated a rule, that *the maxillary palpi when present in Diptera are always in contact with the upper part of the cardines, the stipites.*—Observations on fresh-water rhizopods, with some remarks on their classification, by Prof. G. S. **West.** The author states that whilst examining material from the western districts of the British Islands, interesting rhizopods came under notice, concerning four of which he could find no previous mention. Two of these are species of Hyalosphenia, one is a species of Sphenoderia with a prettily constructed shell, and another is a curious nude form referable to Cienkowski's genus Nuclearia. With regard to the distribution of rhizopods in the west of Scotland, the noticeable feature is the relative scarcity of these animals in the Outer Hebrides as compared with their occurrence on the Scottish mainland. Full reasons are given for the establishment of the Vampyrellidæ as a distinct order of fresh-water rhizopods, to include the genera Vampyrella and Nuclearia.

PARIS.

Academy of Sciences, May 11.—M. Albert Gaudry in the chair.—New studies on a law relating to the electromotive forces developed by the reciprocal action of saline solutions, by M. **Berthelot.** If E is the E.M.F. developed by the action of an acid on a base, and the E.M.F. developed by the action of the corresponding salt on the acid be ϵ_1 and on the base ϵ_2, then the author has established experimentally the law $E=\epsilon_1+\epsilon_2$.—On the traces of the Lutitian sea in the Soudan, by M. **de Lapparent.** Fossils found by French officers in the Soudan, including a new species of Plesiolampas, undoubtedly belong to the Middle Eocene. It may thus be considered as certain that the Lutitian sea, traces of which have been already made out with certainty in the neighbourhood of Dakar, spread out into the heart of the Soudan.—On the existence of radiations capable of passing through wood and certain metals in the rays from an incandescent mantle, by M. R. **Blondlot.** The radiations were detected by their action on very small sparks, the arrangement of the apparatus being similar to that previously described by the author in connection with the radiation of an X-ray focus tube, and also by their photographic action. They resemble in some respects the rays of long wave-length discovered by Rubens, in that both are emitted by an incandescent mantle, and are stopped by water. On the other hand, the Rubens rays are stopped by metals, which are traversed in thin layers by the radiations now described.—On a class of differential equations reducible to Bessel's equation, by M. Alexander S. **Chessin.**—On the zeros of monodrome functions, or with ν branches, by M. Edmond **Maillet.**—On thermomagnetic effects in bismuth-lead alloys, by M. Edmond **van Aubel.**—On the modulus of traction and the coefficient of expansion of vulcanised indiarubber, by MM. **Bouasse** and **Carrière.** In reasoning from the equation $dL=\alpha.dt+\epsilon dP$, dL is usually taken as an exact differential. This, however, is far from being the case; the coefficients α and ϵ are very variable, since they depend upon the previous history of the specimen under examination. It is shown that the value of these coefficients may be made to vary between wide limits by varying the cycle of operations, and it is not possible on theoretical grounds to give the preference to any one of these.—On the electrolysis of alkaline sulphides, by MM. André **Brochet** and Georges **Ranson.** It has been shown in previous work that the final product of electrolysis is sulphate, with an intermediate formation of thiosulphate. Working in concentrated solution at 50° to 70°, the process is entirely different, sulphur being deposited at the anode and sodium at the kathode, hydrogen and sodium hydroxide appearing in the latter case as the secondary products. The sulphur formed dissolves in the sulphide, giving polysulphides.—On benzene-azo-orthobenzyl alcohol and on its transformation into phenylindazol and azodiphenylmethane, by M. P. **Freundler.** The alcohol is easily obtained by the condensation of nitrosobenzene with *o*-aminobenzyl alcohol in presence of alcohol and acetic acid.—Organometallic derivatives of aromatic hydrocarbons containing two halogen atoms in the nucleus, and their interaction with iodine, by M. F. **Bodroux.** The dihalogen derivative reacts with magnesium to give $X.C_6H_4MgX$, and this, with iodine, forms the mixed halogen compound $C_6H_4.XI$. The reaction appears to be general, and has been extended to naphthalene compounds.—On the methylation of ethyl glutaconate, by M. E. E. **Blaise.**—The migration of the methyl group in the camphor molecule, by MM. G. **Blanc** and M. **Desfontaines.**—On the successive action of acids and soluble ferments on polysaccharides of high molecular weight, by MM. Em. **Bourquelot** and H. **Hérissey.**—The diastatic hydrolysis of salol, by M. Emm. **Pozzi-Escot.** The hydrolysing ferments of plant seeds, which act easily upon the esters of the fatty acids, are nearly without action upon the phenol ethers.—On the law of electrical excitation in some invertebrates, by M. and Mme. L. **Lapicque.** It is shown that the law enunciated by Weiss is only an approximate one; the establishment of a more correct formula is reserved for a later communication.—Excretion and phagocytosis in Onychophores, by M. L. **Bruntz.**—On the absorption of the tetanic antitoxin; the immunising action of dry antitetanic serum, by M. A. **Calmette.**—On the reversibility of lipolytic actions, by M. Henri **Pottevin.** If oleic acid be added to a glycerol extract of the pancreas, partial esterification takes place; starting with mono-olein, a partial hydrolysis occurs, and in both cases there is a final state of equilibrium produced, characterised by the same value for the ratio between the weights of the free and combined acid.—The influence of formaldehyde on the growth of white mustard, by MM. **Bouilhac** and **Giustiniani.** When, owing to insufficient light, the chlorophyll assimilation of the plant is rendered difficult, formaldehyde may serve as a plant food, but if the intensity of the light is diminished below a certain amount, this assimilation ceases, the formaldehyde exerts a poisonous effect, and all the plants die.—How far is it possible to modify the habits of plants by grafting? by M. Lucien **Daniel.**—On the spontaneous combustion of balloons, by M. W. **de Fonvielle.** Certain explosions of balloons would appear to be traceable to electrical effects, which determine a spark at the moment the aëronaut grasps the valve rope. As a precaution, the use of indiarubber gloves is suggested in stormy weather.—On the culture of the truffle, by M. Émile **Boulanger.**

May 18.—M. Albert Gaudry in the chair.—The statistics of the minor planets. The distribution of the elements, taking the aphelion longitude as argument. The comparison of the minor planets with short period comets, by M. O. **Callandreau.**—The measurement of the velocity of ships at sea, by M. E. **Guyou.** A return to the oldest form of line log is suggested, with certain modifications. The float is replaced by a light calico bag containing a little sand, the resistance of which is sufficient to form a very satisfactory fixed point. The line is looped in coils and not on a reel, and is fitted with a simple electrical indicator. An accuracy of 1 per cent. is obtainable with this arrangement.—On the distribution of matter on the surface of the earth, by M. G. **Lippmann.**—The conductivity and residual ionisation of solid paraffin under the influence of the radium radiation, by M. Henri **Becquerel.** It is easily shown that solid paraffin becomes a conductor whilst under the action of the radium emanation, and this is not immediately lost on the removal of the radium, but, although diminishing rapidly, is still appreciable during about half an hour.—The preparation and properties of cæsium ammonium and rubidium ammonium, by M. Henri **Moissan.** These substances were obtained by the action of liquid ammonia on the metals, the methods employed being similar to those previously described for sodium, potassium, and lithium. Cæsium ammonium is crystal-

line, and takes fire at once in the air. Its analysis gave figures corresponding to the formula $CsNH_3$, and the rubidium compound has an analogous composition. The solutions of these substances in liquefied ammonia have been utilised for the production of the carbides of cæsium and rubidium.—Secular perturbations of the first degree with respect to the eccentricity, by M. Jean **Mascart**.—On the visibility of the eclipsed lunar disc during the second half of the eclipse of April 11–12, by M. **Amann**. The peculiar and exceptional visibility of the eclipsed portion of the moon's disc was confined to the second part of the eclipse.—On the decomposition of a linear substitution, real and orthogonal, and on a product of inversions, by M. Léon **Autonne**.—On the value of averages in meteorology, and on the variability of temperatures in France, by M. Alfred **Angot**. It is pointed out that the arithmetical mean of a series of experimentally observed numbers is only the most probable result if the causes of error are purely accidental, and that this latter condition does not necessarily hold in meteorological observations. Observations taken in France over a period of fifty years are discussed with the view of determining between what limits this condition is satisfied.—On the electrical conductivity of selenium in the presence of bodies treated with ozone, by M. Edmond **van Aubel**. Substances after treatment with ozone, and which are capable of being attacked by it, increase the electrical conductivity of selenium, the rate of return to the original resistance being extremely slow.—On the transmission of photographs by means of a telegraph wire, by M. **Korn**. The image is produced photographically upon a rotating plate by means of the light from a vacuum tube, and the latter is worked by high frequency Tesla currents, governed by a selenium cell at the transmitting end of the wire. The rate of transmission is slow, owing to the inertia of the selenium.—On the theory of coloured indicators, by M. P. **Vaillant**. From a quantitative study of the colour of solutions of paranitrophenol and its salts, the conclusion is drawn that the definition of an indicator given by Ostwald and Nernst is incomplete.—Electrolysis of the sulphides of the alkaline earths, by MM. André **Brochet** and Georges **Ranson**. In concentrated solutions, electrolysed at 60°, sulphur, baryta and hydrogen are produced, indicating that the primary products are sulphur and barium. There is no evidence of the production of any oxidation products.—On a new method for the estimation of the halogens in organic compounds, by MM. H. **Baubigny** and G. **Chavanne**. The substances are oxidised by chromic acid mixture in presence of a silver salt; chlorine and bromine are set free, whilst iodine is completely converted into iodic acid. Test analyses of several iodine compounds prove the accuracy and convenience of the method.—The action of ethyloxalyl chloride on mixed organo-magnesium compounds, by M. V. **Grignard**.—The action of the bases of the alkaline earths upon the salts of pyrogallol-sulphonic acids, by M. Marcel **Delage**.—A new method for the estimation of glycerol, by M. A. **Buisine**. The process is based upon the production of a mixture of hydrogen and methane by the interaction of glycerol and a mixture of potash-lime and caustic potash at 350°. It has the advantage of requiring a very small quantity of material, and is very rapid.—A new test for lead and manganese, by M. R. **Trillat**.—On the comparative physiology of the two kidneys, by M. J. **Albarran**. In unit time, the two kidneys secrete different quantities of urine of different composition. There is a partial compensation in that the kidney producing the larger quantity of urine secretes a less concentrated liquid.—On a point in the anatomy of some Oculininæ and Pæciloporinæ, by M. Arm. **Krempf**.—On a cause of variation in fossil fauna, by M. H. **Douvillé**.

DIARY OF SOCIETIES.

THURSDAY, MAY 28.

ROYAL SOCIETY, at 4.30.—On the Bending of Waves round a Spherical Obstacle: Lord Rayleigh, O.M., F.R.S.—Sur la Diffraction des Ondes Électriques à propos d'un Article de M. Macdonald: Prof. H. Poincaré, For.Mem.R.S.—On the Theory of Refraction in Gases: G. W. Walker.—An Analysis of the Results from the Kew Magnetographs on *Quiet* Days during the Eleven Years 1890 to 1900, with a Discussion of Certain Phenomena in the Absolute Observations: Dr. C. Chree, F.R.S.—On a Remarkable Effect produced by the Momentary Relief of Great Pressure: J. Y. Buchanan, F.R.S.—Evolution of the Colour-Pattern and Orthogenetic Variation in Certain Mexican Species of Lizards with Adaptation to their Surroundings: Dr. H. Gadow, F.R.S.—Researches on Tetanus: Prof. Hans Meyer and Dr. F. Ransom.—The Hydrolysis of Fats in vitro by Means of Steapsin: Dr. J. Lewkowitsch and Dr. J. J. R. Macleod.—On the Optical Activity of the Nucleic Acid of the Thymus Gland: Prof. A. Gamgee, F.R.S., and Dr. W. Jones.

ROYAL INSTITUTION, at 5.—Electric Resonance and Wireless Telegraphy: Prof. J. A. Fleming, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.—Annual General Meeting.

FRIDAY, MAY 29

ROYAL INSTITUTION, at 9.—Some Physical Problems of the Ocean: J. Y. Buchanan, F.R.S.

SATURDAY, MAY 30.

ROYAL INSTITUTION, at 3.—The "De Magnete" and its Author: Prof. S. P. Thompson, F.R.S.

TUESDAY, JUNE 2.

ROYAL INSTITUTION, at 5.—The Work of Ice as a Geological Agent: Prof. E. J. Garwood.

VICTORIA INSTITUTE, at 4.30.—The Living God of Living Nature: Lionel S. Beale, F.R.S.

WEDNESDAY, JUNE 3.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.

THURSDAY, JUNE 4.

CHEMICAL SOCIETY, at 8.—Imino-ethers corresponding to Ortho-substituted Benzenoid Amines: G. D. Lander and F. T. Jewson.—(1) Formation of an Anhydride of Camphoryloxime; (2) The Mutarotation of Glucose as influenced by Acids, Bases and Salts; (3) The Solubility of Dynamic Isomerides: T. M. Lowry.—(1) Isomeric Partially Racemic Salts containing Quinquevalant Nitrogen. Part X. The Four Isomeric Hydrindamine *d*-Chlorocamphorsulphonates $NR_1N_2H_3$; (2) Isomeric Compounds of the Type $NR_1R_2H_3$: F. S. Kipping.—The Hydrolysis of Ethyl Mandelate by the Fat Splitting Enzyme, Lipase: H. D. Dakin.

ROYAL INSTITUTION, at 5.—Electric Resonance and Wireless Telegraphy: Prof. J. A. Fleming, F.R.S.

RÖNTGEN SOCIETY, at 8.30.—On the Electric Field surrounding the X-Ray Tube: Rev. P. Mulholland.

LINNEAN SOCIETY, at 8.—On the Anatomy and Development of *Comys infelix*: Miss Alice L. Embleton.—Scottish Freshwater Plankton: Messrs. W. and G. S. West.

FRIDAY, JUNE 5.

ROYAL INSTITUTION, at 9.—The New Star in Gemini: Prof. H. H. Turner, F.R.S.

PHYSICAL SOCIETY, at 5.—Special Meeting at University College.—Radio-active Processes: Prof. Rutherford.

SATURDAY, JUNE 6.

ROYAL INSTITUTION, at 3.—The "De Magnete" and its Author: Prof. S. P. Thompson, F.R.S.

CONTENTS.

THURSDAY, JUNE 4, 1903.

INFINITE SERIES.

Théorie élémentaire des Séries. Par Maurice Godefroy: avec une Préface de L. Sauvage. Pp. viii + 268. (Paris: Gauthier-Villars, 1903.) Price 8 francs.

INFINITE series present themselves in mathematics in different contexts, serve different purposes, and admit of different interpretations. The simplest case is when, from a numerical sequence $(u_1, u_2, u_3, \ldots)$, we derive the series

$$u_1 + u_2 + u_3 + \ldots$$

which we may denote by Σu. It is assumed that there is a rule for calculating u_n when n is assigned; if we write s_n for $u_1 + u_2 + \ldots + u_n$, there exists a sequence $(s_1, s_2, s_3, \ldots)$ and we may, in fact, regard Σu as being, in a manner, a symbolical expression of this sequence. When we say that Σu is convergent and its sum is s, what is really meant is that the sequence (s_n) converges to the limit s.

To Cauchy and Abel is mainly due a strict theory of such arithmetical series. They showed that, whether its terms are real or complex numbers, a series of this sort may be divergent, indeterminate, or convergent; and that series which are absolutely convergent may be combined by processes which we may call addition, subtraction, multiplication, and division. There is one part of this theory which, even yet, is not always made so clear as it might be. Suppose that we have two sequences (u_n), (v_n) of such a character that every element u_p of the one occurs as an element v_q in the other, and conversely; that this is a (1, 1) correspondence, that is to say, that each element of one sequence is associated with one, and only one, of the other; and, finally, that when p is finite, q is also finite, and conversely. In this case we may call (v_n) a permutation of (u_n). When Σu_n is absolutely convergent, so is Σv_n, and the sums of these two series are the same; it is this property, really, that makes absolutely convergent series so easy to work with. Properly speaking, a series is distinct from its permutations; but in the case of an absolutely converging series this distinction may be ignored. It is a remarkable fact that a series and one of its permutations may both converge and have different sums. It is rather unfortunate that the phrase "changing the order of the terms in a series" is still used; it is certainly best to regard a series as defined, not merely by its terms, but by the order in which they are written.

After discussing this arithmetical theory, M. Godefroy proceeds to the next simplest case, when the terms of the series are functions of a variable x which is supposed to assume numerical values. Here the distinction between uniform and non-uniform convergence appears, a distinction first emphasised by Stokes and Seidel. In the sequence (s_n) derived from a convergent series of this kind, the index n for which s_n first differs from the sum of the series by less than an assigned quantity h is, in general, a function of x as well as of h; so that for particular values of x and their immediate neighbourhood n may be enormously large even for values of h which, though small, are not infinitesimal; accordingly the series is no longer available for practical calculation. At such places the convergence ceases to be uniform; the convergence is uniform wherever it is possible to assign, in terms of h but *not* of x, a value of n for which $|s_n - s| < h$.

Of course, the most important series of this class are power-series, and in his third chapter M. Godefroy deals with them at some length. On pp. 67–69 he gives Dirichlet's proof of Abel's fundamental theorem that when a power-series is convergent its value at the boundary of its circle of convergence is the limit of its value as x approaches the boundary. To learn to appreciate the necessity for proving this theorem is a good exercise for the mathematical student; it looks so obvious and is yet so far from being a truism.

The remaining three chapters are on the exponential function, the circular functions, and the gamma-function respectively. The noteworthy features are that sin x, cos x are defined by power-series, that the transcendence of e is demonstrated, and that the properties of the gamma-function are deduced, after the manner of Gauss, from the product $\Pi(n,x)$. M. Godefroy points out that Weierstrass's formula

$$\frac{1}{\Gamma(x)} = xe^{Cx}\Pi\left(1+\frac{x}{n}\right)e^{-x/n}$$

was explicitly given in 1848 by F. W. Newman (*Camb. and Dubl. Math. Journ.*, vol. iii. p. 59).

The final chapter is the one which presents most novelty in the shape of actual results; thus, besides the series of Stirling, we have various interesting formulæ due to Prym, Hermite and others. But M. Godefroy's style and method will attract the reader's attention throughout; he combines simplicity with rigour, and is neither dry nor diffuse. His work is one which may be cordially recommended, especially to mathematical students; not the least of its merits is its excellent bibliography, which is just what a treatise of this sort should contain.

M. Godefroy does not explicitly introduce the complex variable, but it is easy to complete the chapter on power-series so as to make its results apply when x is complex. Thus we have, on the whole, a discussion, with illustrations, of numerical series, and of power-series which define functions of a variable within a circle of convergence.

Incidentally, we have examples of two other kinds of series. Stirling's formula is the classical example of a series which does not define a function, but which, while ultimately divergent, serves to calculate the numerical value of a function very exactly for any sufficiently large value of x. Such asymptotic series have been recently studied by Poincaré, Borel and others, and their properties are no longer a mystery.

Again, Lambert's series

$$\frac{x}{1-x} + \frac{x^2}{1-x^2} + \ldots + \frac{x^n}{1-x^n} + \ldots$$

is an example of a series which serves for enumeration. If each term is expanded in powers of x, and the result collected, we get $\Sigma\psi(n)x^n$, where $\psi(n)$ is the number of ways of solving $n = \delta\delta'$ with integral values of δ, δ', the order of δ, δ' being taken into account except when they are equal. Thus $\psi(n) = 2$ when n is prime, but not

otherwise. So long as $|x| < 1$, Lambert's series defines a function of x; calling this $f(x)$, a prime number p is distinguished by the fact that it makes

$$D_x{}^p{}_r(x) = 2p(p!)$$

when $x=0$. There are many remarkable instances of arithmetical truths derived by constructing an enumerative series (purely symbolical, in the first instance) and then investigating its properties as a function of x. Ultimately, of course, the results obtained must depend upon purely arithmetical considerations; but transcendental analysis supplies, in such cases, a kind of machine, by which, with slight effort, theorems are verified, or even suggested, although the proof of them by strictly arithmetical methods may be very difficult. Whether Lambert's series can be used in this way to simplify the problem of the frequency of primes still remains an open question. G. B. M.

A PLEA FOR INTERACTION.

Geist und Körper, Seele und Leib. Von Ludwig Busse. Pp. x+488. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1903.) Price 8.50 marks.

IN this book the author aims at finally establishing a doctrine of "interaction." Previous expositions in less comprehensive form have already been criticised by eminent writers; to these objections the author now replies. The result is a veritable encyclopædia of views on this question; authors of all nationalities are here cited to defend themselves against criticisms which are throughout shrewd and relevant. In the mass of material the author's particular theory is apt to be obscured; a strictly methodical procedure has to some extent obviated this defect. After a refutation of materialism, adequate for its purpose as *entrée*, we come to the *pièce de résistance*, entitled "Parallelism or Interaction?" Here parallelism is discussed under the heads modality (is parallelism a metaphysical doctrine or merely a hypothesis?), quantity (must it be partial or complete?), and quality (materialistic, realistic-monistic, idealistic-monistic, and dualistic forms). From this catalogue there finally emerge as "valid forms" only the complete, the realistic-monistic, the idealistic-monistic, and the dualistic forms. The method of criticism employed is called by the author "immanent." Internal dissensions reduce the various doctrines to the vanishing point; those alone survive which do not contain in themselves any elements contradictory to parallelism. The crucial point comes when the idealistic-monistic form is discussed. The author holds an idealistic-spiritualistic doctrine, and is therefore concerned to show that this does not necessitate parallelism, that interaction is not only possible, but preferable. He relies mainly on the unity of consciousness, and the necessity of including activity as subjectively known in our view of the Whole. The arguments against "conservation of energy," "continuity," and naturalistic positions in general are then brought forward. The author is emphatically opposed to any compromises. Between mind and matter the break is absolute; activity without expenditure of energy, the extension downwards to the unconscious or to *quelque chose d'analogique*—in short, compromise of all kind is rejected. Philosophy must here take its stand upon experience, and claim that interaction alone does justice to the facts. The rejection of a preestablished harmony makes it necessary to assert that ultimately we must formulate any given series of events, not as one or as two homogeneous series, either physical (as $a\ b\ c\ldots$) or psychical ($\alpha\ \beta\ \gamma\ldots$), but as a compound series of the form $a\ \beta\ c\ \delta$, &c. Similarly the rejection of any development of mind from lower elements is followed by the conclusion (after Lotze) that it supervenes on a certain development of "Zellengruppe." It follows that so far as interaction is concerned we must assert a dualism; the two systems which interact must be kept distinct; the ultimate unity is not to be found in their nature, but in the fact of their interaction; we have not to piece together the world, but to accept its living unity.

Clearly such a theory claims attention more for the consequences to which it looks than for the advantages it attains. So far we must regard the Weltanschauung of the closing section as much more than a "dessert." Here there appears an "All-Geist," and with it new possibilities; unfortunately the binder omitted some pages here, and criticism must therefore turn upon him rather than upon the author. As an exposition of how experience may be treated in the interests of a Weltanschauung, we have here an admirable discussion. Much of it is common property among writers on the philosophy of psychology. But refutation has before now proved a two-edged sword, and on the crucial points, the subjects of activity and of development, the author seems to glide from proof to assertion. The idealistic treatment of the two factors said to interact presumably forms the ground of a final unity; the question "how" is more easily solved *ambulando* than *cogitando*. It seems to require more than the author's theory of Thing-monads and Soul-monads—more even than the binder can have omitted. G. S. B.

THE NEW ENCYCLOPÆDIA.

Encyclopaedia Britannica. Vol. xxxi. New volumes. Vol. vii. Mos—Pre. (London: A. and C. Black; and the *Times* Office, 1902.)

THE prominence given to scientific subjects in the seventh of the new volumes of what has long been regarded as our national encyclopædia serves in a measure to indicate how large a part the work of men of science has taken in the increase of knowledge during the last quarter of a century. Among articles of prominent importance in this volume, so far as the student of science is concerned, are those dealing with palæobotany, pathology, and physiology, though there are many other articles of a less exhaustive kind dealing with problems of great scientific interest. Technological questions receive due attention, and are represented, among others, by essays on navies, ordnance, paper manufacture, petroleum, photography, and elec-

tric, hydraulic, and pneumatic power transmission. Students of geography and history are provided with an abundance of material, including the latest statistics referring to the chief countries of the world the names of which fall alphabetically between Natal and Portugal, besides an elaborate account of the polar regions, and an able review of the present state of our knowledge of oceanography. Mathematicians will find the article on "Number" both interesting and original, and readers who prefer biographical studies will meet with appreciative estimates of the lives of such celebrities as Owen, Paget, and Pasteur, to name only three.

But no mere mention of a few of the contents can serve more than to give a vague idea of the variety of valuable material brought together in this volume, and the space available makes it possible to refer only to a few of the chief contributions.

The prefatory essay of this volume—and it must be remembered that these essays are a distinguishing characteristic of this new edition—is by Mr. Frederick Greenwood, and deals with the influence of commerce on international conflict. In this scholarly presentation of an important problem, Mr. Greenwood shows how the growth of commerce has given rise in recent times to dreams of the extinction of war. He goes on to explain, however, how war became later to be regarded as a trade weapon and an instrument for the provision of new markets; and as the discoveries of men of science have placed resources for the destruction of men at the disposal of the armies of the world so terrible in their efficiency that, to ensure any chance of success in a war between great Powers, each of them must have armies so large and so expensively equipped as to lead to a growing likelihood of war becoming so dreadful and so costly that it would not be endured. Yet notwithstanding the horror and brevity of modern battles, humanity still seems able to bear the excess, and militarism flourishes.

Of another factor influencing the industrial competition of the nations Mr. Greenwood takes no notice, and that is the increased attention being paid by the leading nations to the higher education of their manufacturers and merchants. The combined efforts of armies and nations are not enough to secure commercial supremacy. A nation must, in addition, provide a sufficient number of institutions of higher education to secure opportunities for its citizens to become conversant with modern scientific knowledge, able to apply the principles of science to modern industrial problems, and to extend the bounds of science into the unknown. The volume itself does not, we find, ignore the importance of higher technical education, for in addition to articles with a less direct bearing on the subject, an essay on polytechnics by Sir Joshua Fitch is included. The subject does not appear to have been allotted the amount of space its importance merited, and the consequence is that metropolitan polytechnics are alone described. It is a pity that the opportunity could not have been taken to familiarise British readers with the complete and lavish provision of institutions abroad corresponding to these polytechnics. The comparison to which such an article must have given rise would have shown England's lamentable deficiency and the low position she must be assigned when the sacrifices made by the leading peoples for the establishment of institutions of the higher learning are passed in review.

BIO-CHEMISTRY.

The Chemical Changes and Products Resulting from Fermentations. By R. H. Aders Plimmer. Pp. vi+184. (London: Longmans and Co., 1903.) Price 6*s.* net.

THE number of chemists who are interested in biological problems is now gradually on the increase, whilst, on the other hand, the biologist realises the importance of a further investigation of the chemical changes concomitant with life. In these circumstances, the book of Dr. Aders Plimmer cannot fail to be particularly welcome, and the perusal of this admirable *résumé* of the work in the borderland between biology and chemistry will indicate to the reader how much has been done and how much still remains to be done in this most difficult field of research.

Under his treatment of polysaccharides the author gives a succinct account of the chemistry of starch, and then proceeds to discuss the changes undergone by monosaccharides and glucosides. In this connection due prominence is given to the recent important observations of Croft Hill, Emmerling and E. Fischer and E. F. Armstrong on reversible ferment action. In the chapter on changes in esters reference is made to the work on lipase, where Kastle concludes that ferments do not act on substances which can be electrolytically dissociated. It should be noted, however, that Slimmer has subsequently pointed out that this view cannot be maintained, since glucovanillic acid and other electrolytes are attacked by emulsin. Other chapters include changes in urea and uric acid, blood, albumins, and changes occurring as a result of oxidation and reduction. Nitrification and denitrification are also considered, and the volume is completed by an account of the changes occurring as the result of putrefaction.

It is pointed out in connection with lactic acid production by microorganisms that the usual product is the inactive acid, but that one of the pure optically active forms may sometimes be obtained. In this latter case the author is apparently of the view that the inactive acid is first of all formed and then converted into the one active form by the selective action of the organism. Experimental evidence, however, seems to show that, if the action were of this nature, the resulting product would not be the pure active acid but rather a mixture of inactive and active acids. Frankland's resolution of *i*-glyceric acid, where the one active constituent is attacked by *Bacillus ethaceticus* and the other apparently remains untouched, is altogether exceptional. In those cases, however, where the lactic acid obtained is optically active, but is mixed with some of the inactive form (as in Harden's experiments on the action of *Bacillus coli communis* on *d*-glucose, &c.), the possibility of the intermediate

formation and subsequent partial resolution of inactive acid may be maintained. In the discussion of Harden's results (p. 69), it is not clear why the lactic acid formed should be optically active at all; from the description given it appears that the asymmetry of the molecule must disappear altogether.

Dr. Plimmer points out that many of the changes caused by living organisms may possibly be due to enzyme action. In addition to his experiments with zymase, Buchner has lately submitted further experimental evidence in favour of this conception, since, conjointly with Meisenheimer, he has proved that from *Bacillus acidificans longissimus* an enzyme may be prepared which converts cane sugar into lactic acid. The same investigators have also shown that the conversion of ethyl alcohol into acetic acid may be accomplished by an enzyme which they obtained from vinegar bacteria.

Buchner's work on zymase surely merits more than the few lines which the author devotes to it, especially since space is found for an account of many discoveries which are of much less fundamental importance. Reference might also have been made to Bredig's experiments on inorganic ferments. Further, one cannot help regretting that a brief account of Emil Fischer's work on the decomposition products of albuminoids is not incorporated in the volume. Those are, however, minor objections. British workers in different sciences will appreciate Dr. Plimmer's account of biochemistry. A. McK.

OUR BOOK SHELF.

Metallurgical Laboratory Notes. By Henry M. Howe, Professor of Metallurgy in Columbia University. Pp. xiv+140. (Boston: The Boston Testing Laboratories, 1902.)

THE time has passed when practical teaching in metallurgy was a synonym for little more than a course of exercises in assaying. No one recognised this sooner and more fully than Prof. Howe, and his students now devote much of their time in the laboratory to carrying out experiments illustrating the principles which underlie the various processes of the treatment of ores and metals in works. This little volume contains a description of ninety-one such experiments of both educational and instructive value, and constitutes the first attempt to embody the new methods in book form. The author expresses in the preface his feeling that the series of experiments now published is incomplete and shows a lack of balance, and probably many metallurgists will find themselves constrained to agree with him. Those teachers who are convinced that ore treatment is still by far the most important branch of the subject may object to a system in which the majority of the experiments are directed to the study of the treatment and properties of metals. Even the methods will not command universal approval in this country, where students are encouraged to learn to overcome the difficulties occasioned by the use of indifferent implements on the grounds that they will be better fitted by such training to deal with the more serious difficulties unavoidably encountered in the industries. The smoothing away of obstacles, and the reduction to a minimum of the practice in manipulation, have been characterised as "spoonmeat methods." It must be admitted, however, that these views are likely to be held most firmly by the professors who are least adequately supplied with laboratory equipment. Prof. Howe considers that in proportion as less time is devoted to details of manipulation, more leisure is available to the student for "the unwelcome task of thinking," than which nothing could be more important. Perhaps it might be argued that practice in manipulation would make the best laboratory workers, and that practice in thinking would assist in turning out the best general managers. The book is extremely welcome, and breaks ground that must soon be assiduously cultivated. It will be carefully studied by all who have the improvement in the training of metallurgists at heart. T. K. R.

Nature Studies in Australia. By W. Gillies and R. Hall. Pp. v+299. (Melbourne and London: Whitcombe and Tombs, Ltd., n.d.) Price 2s.

THE recognition of the importance of "nature-study," if we are to know anything really worth knowing about animals and plants, in Australia is a satisfactory sign of the times, and an indication that throughout the world the old-fashioned ways of teaching are to be abolished, and also that the days of mere section-cutting and skin-describing are numbered. The greater part of the present little volume is devoted to birds (mammals being left out), of the life-histories of which Mr. R. Hall has for many years been an enthusiastic student, and we must congratulate both authors on the mass of interesting information they have concentrated into such a small space with regard to a number of characteristic Australian species. The majority of the numerous illustrations are the results of the authors' own cameras, and, although necessarily on a small scale, they are, for the most part, excellent examples of bird-photography. One great advantage possessed by the authors is that their subject has a freshness which cannot be claimed for descriptions of British bird-life, and this gives a charm to their work which stay-at-home writers must find it difficult to equal. We must confess, however, to a feeling of dissatisfaction at the use of names like "lunulated honey-eaters" for certain of the species, which are certainly not examples of "nature-teaching," and we are by no means sure that we quite like the "pupil and teacher" style on which the work is planned—it savours a little too much of "Sandford and Merton."

One fact appears of more than usual interest. It is commonly stated in ornithological works that every species of migratory bird breeds in the most northern portion of its range. According, however, to the authors, at least one Australian bird—the double-banded or sand dotterel—goes south to breed, travelling to the south of New Zealand, "that is to say, as far towards Antarctica as it can now get."

Space, we regret to say, prevents our going deeper into the contents of the work before us, the latter portion of which is devoted to the lower vertebrates and invertebrates. We can, however, safely recommend it to the best attention of teachers of nature-study, if only for the fact that a book written on the spot is worth a dozen compilations made elsewhere. The price renders it within the reach of all. R. L.

Considerazioni agrarie sul Piano di Capitanata. By Dr. Nestore Petrilli. Pp. 87. (Naples, 1902.)

THIS work consists of a monograph upon the agricultural conditions which prevail in the great plain of the Capitanata, constituting the northern part of Apulia. Such monographs, which are regularly produced upon the Continent, and provide great assist-

ance to the statesman wishing to get a sound idea of the state of an industry subject to such local variations as agriculture, seem to have dropped out of favour in this country; to parallel them we must go back fifty years to the prize reports on the farming of the various counties which used to be a feature of the earlier numbers of the *Journal* of the Royal Agricultural Society.

The Tavoliere di Capitanata is a dry flat plain with an annual rainfall of only eighteen inches, and a mean temperature of more than 60° F.; the prevailing calcareous subsoil results in there being but little surface water, while the few rivers descending from the Apennines are torrential in their nature, and in consequence have formed a considerable area of marsh. The agriculture of the district is of a primitive character, much of it is pastoral, this being one of the sheep-producing districts of Italy; the cultivated land is farmed on a kind of four-course rotation of hard wheat (macaroni wheat), wheat, oats and fallow, and on the poorer land an even simpler rotation of wheat or oats and fallow alternately is practised. A certain acreage is also occupied by vines and olives.

The author, after a preliminary discussion of the meteorological conditions, geology, &c., of the district, proceeds to describe the system of management which prevails, and sets out in detail the cost of the various operations, rates of wages, and gross returns as regards sheep, wheat and vines. As a means of improving the condition of agriculture he lays stress on the introduction of forage crops, such as temporary pastures, sainfoin and lucerne, instead of the present primitive and exhausting alternation of cereals and fallow.

The Stellar Heavens. By Ellard Gore. Pp. xxxii + 128. (London: Chatto and Windus, 1903.) Price 2s. net.

THE author has brought together in a small compass a list of the more prominent objects in the heavens for the use of possessors of small telescopes. The list is accompanied also by brief historical and introductory information applicable to each class of object treated. There are five chapters in all, and these are devoted to the following subjects:—Stars, double, multiple and binary stars, variable stars, star-clusters and nebulæ, and the stellar universe. In the first of these a brief account, among other topics, is given of the classifications of stellar spectra, but unfortunately the reader is not told that Vogel's classification is based on the assumption that all stars are decreasing in temperature, while a natural and more recent classification, dividing the stars into groups in which they are increasing or decreasing their temperature, is altogether omitted.

The paragraph devoted to the explanation of temporary or new stars is needlessly brief considering the number of views expressed on this important subject. On the other hand, an excellent account is given of the methods of observing the brighter variable stars which are in the reach of amateurs, and it is hoped that this interesting branch of astronomy, one specially suitable for those who have only opera glasses at their service, will be taken up more generally.

The volume will, however, be a very useful help for directing the observer's attention to the various more conspicuous objects in the sky, and although it does not pretend to take the place of that well-known friend of amateurs, namely, Webb's "Celestial Objects for Common Telescopes," it will prove a serviceable guide. The only erratum found was the misspelling of the name of Klinkerfues on p. 23, although the name is indexed correctly.

Departmental Notes on Insects that Affect Forestry. By E. P Stebbing, F.L.S., F.E.S., Forest Entomologist under the Government of India. No. 2. Pp. vii+151–334; plates vii–xix. (Calcutta, 1903.)

THE importance of economic entomology is now fully recognised by the Indian Government, and the publication before us is devoted chiefly to Scolytidæ and other beetles injurious to the bark and leaves of trees, and to their parasites; a few moths and scale-insects are also noticed. Each species occupies several pages, and is fully dealt with under various headings, the most important being description, life-history, relations to the forest, points in the life-history requiring further observation (an extremely important matter), protection and remedies, localities, parasites, fungi, &c. Several species are referred to under their generic names only, but this will not render their identification a matter of any great difficulty. The illustrations are fairly good, and many of them are devoted to galleries of Scolytidæ and to different portions of trees attacked by insects. The illustrations of the Coccid, *Monophlebus Stebbingi*, Green, on plate 14 are very interesting. We are sorry that Mr. Stebbing has overlooked the necessity for adding the author's name to every described species mentioned; it is done in some cases, but is frequently omitted, and many of the species described have "M.S." appended to their names. We presume that these are names published for the first time by Mr. Stebbing himself, in which case he should either have added his own name or else "n. sp."

We are glad to notice the increase of well-illustrated publications on economic entomology, for their value is considerable, both from a practical and from a scientific point of view.

Analytical Chemistry. By F. P. Treadwell, Ph.D. Translated from the second German Edition by W. T. Hall, S.B. Pp. xi+466. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 3 dollars.

THE text-book is compiled from lectures delivered by the author at the Polytechnic Institute at Zurich. The matter is, as one might expect, very largely explanatory of the various reactions, that is to say, it is a book to be studied rather outside than in the laboratory. From this point of view it doubtless serves a useful purpose, for every reaction is clearly described and illustrated by an appropriate equation.

One may doubt sometimes the expediency of simplifying all analytical operations on paper in this way, but, provided practical experience is added as a corrective, the value of an equation as a general guide to a reaction can do no harm.

The book is written in a thoroughly scientific spirit —not a common characteristic of books on this subject —and the author is conversant with the modern theory of analytical chemistry, to which reference is frequently made.

Seeing that prominence is given to minerals in which the different elements occur, one misses the refinements of blowpipe analysis which Plattner and Richter did so much to develop. Possibly this might have made the volume too bulky. As it is, the information seems accurate and complete. There are plenty of tables of separation, and there is a section at the end devoted to the rarer elements. The book is printed on good paper in clear type, and is bound in a substantial cover. Altogether the external appearance, for a work on qualitative analysis, produces a very favourable impression. The translator has done his work well. Whether this justifies the prominence given to his name on the back can scarcely be decided by the reviewer.

J. B. C.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Coleridge's Theory of Life.

THE old subject of the nature of the vital force or vitality having lately been under discussion, allow me to remind some of your readers that Coleridge did not hesitate to enforce his opinion that it came into the domain of the scientific inquirer, and appertained to the other forces in nature. I cannot express an opinion on his theories of the nature of life, but his holding them in any tangible form has had great weight with some persons, in consequence of his being an orthodox Christian, belonging to what is called the religious world, yet he considered that the nature of life was open to investigation like any other natural phenomenon.

I may be allowed to quote a few passages for the information of those who are not familiar with his essay on the "Theory of Life." Coleridge's idea was that physical life is a process or mode of operation, as we recognise under such names as magnetism chemical affinity, for these, he says, by their own properties affect all the results observed in life. "Life supposes a universal principle in nature with a limiting power in every particular animal, constantly acting to individualize and as it were *figure* the former. Thus then life is not a thing—a subsistent hypostasis—but an act and process." "To account for Life is one thing, to explain Life another. To a reflecting mind indeed, the very fact that the powers peculiar to life in living animals *include* cohesion, elasticity, &c. (or, in the words of a late publication) 'that living matter exhibits these physical properties' would demonstrate that in the truth of things, they are homogeneous and that both the classes are but degrees and different dignities of one and the same tendency. Unless therefore a thing can exhibit properties which do not belong to it, the very admission that living matter exhibits *physical* properties, includes the further admission that those physical or dead properties are themselves vital in essence, really *distinct* but in appearance only *different*; or in absolute contrast with each other." "If I were asked for what purpose we should generalise the idea of Life thus broadly, I should not hesitate to reply that were there no other use there would be some advantage in merely destroying an arbitrary assumption in natural philosophy and in reminding the physiologists that they could not hear the life of metals asserted with a more contemptuous surprise than they themselves incur from the vulgar when they speak of the life in mould or mucor. But this is not the case. This wider view fills up the arbitrary chasm between physics and physiology and justifies us in using the former as means of insight into the latter."

The author then proceeds to discuss his argument through the lowest creatures in animal life until he reaches man.

"The arborescent forms on a frosty morning to be seen on a window or pavement must have *some* relation to the more perfect forms developed in the vegetable world." He then alludes to the different classes of animals, and says, "as the individuals run into each other so do the different genera. They likewise pass into each other so indistinguishably that the whole order forms a very network. Man forms the apex of the living pyramid. He has the whole world in counterpoint to him but he contains an entire world within himself."

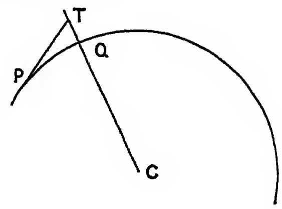
It is clear, therefore, that Coleridge (and others may do the same), whilst holding strictly to the belief in a spiritual existence, yet regarded vitality from quite a different point of view, resulting, indeed, from a combination of forces as we see in other phenomena of nature. SAMUEL WILKS.

Psychophysical Interaction.

SIR OLIVER LODGE says (p. 53) that he would "interfere with the course of nature," regarded as a mechanically determinate problem, even by lifting a log. Why so? The course of nature is exactly what happens, is it not? It is the business of scientific men to find out the course of nature, and the various connections which give it coherence and consistency and determinancy. This has been largely done, even in vital processes: and in the obscurer regions of psychics it seems probable that the course would be determinate if we knew all the circumstances. In any case we have nothing else but the course of nature to go by, in the determination of its laws, and that psychic phenomena are natural phenomena is, it seems to me, the only rational view to take. OLIVER HEAVISIDE.

May 21.

MAY I contribute a pictorial illustration to the controversy raised by Sir Oliver Lodge?



P Q, part of a circular path described by a body of mass m round a fixed centre C, under the influence of a constant centripetal force of magnitude F. Whether this is supplied by a string with a tension F or by an attraction which will be constant if the path is circular does not seem to matter in the least.

Now let P T be the tangential distance which would be traversed in a time t if the centripetal force were absent.

When that force is introduced, P will come to Q instead of to T, and the work done by the force consists of pulling the mass from T to Q in the time t. The energy required to do this is $F \times TQ$, and the same amount is required and absorbed in each successive interval of t. This result is not affected by calling F a guiding force, which it is. If instead of a body describing a circle we had dealt with a body at rest in the position T, the energy required to bring it to Q would be exactly the same.

If Newton had had to express himself (modern fashion) in terms of energy, can we imagine him dealing with the problem except in some such way as my drawing indicates?

Athenæum. G. W. HEMMING.

ATMOSPHERIC ELECTRICITY.

UNTIL within the last two or three years, the advances made in our knowledge of atmospheric electricity were mainly due to the investigation of the electric field of the earth. An interesting summary of the facts brought to light by such investigations will be found in a paper by Exner in "Terrestrial Magnetism and Atmospheric Electricity" (vols. v., p. 167, and vi., p. 1).

Except at or near places where rain (or other form of precipitate) is falling, there is in the free atmosphere an electric field tending to drive positive electricity downwards; the earth's surface is thus in fine weather regions negatively charged. The strength of the electric field and the magnitude of the charge per square centimetre on level ground at a distance from trees or buildings may be found by observing the potential at a measured height. According to Exner, the normal (fine weather) potential gradient in European latitudes varies from about 80 volts per metre in summer to 400 or 500 volts per metre in winter.

It has now been established by means of balloon observations that the intensity of the electric field in fine weather begins to diminish when a comparatively small altitude is reached, and at a height of 5000 metres has only a small fraction of the intensity at the earth's surface. This shows that the lower layers of the atmosphere possess a positive electrification very nearly equivalent to the negative charge on the ground.

For the study of the variations of the electric field at a given place a large mass of material is furnished by the electrograph curves obtained at various observatories. There is a well-marked annual variation in the intensity of the electric field; the maximum occurs in winter and the minimum in summer, the midwinter values being five or six times as high as those of midsummer. The daily variation is less regular, and its character depends on the place of observation and on the season of the year. Three types are recognisable according to Exner. Most commonly there are maxima about 8 a.m. and 8 p.m., with night and noon minima between them. There may, secondly, as on the Eiffel Tower[1] and in winter at many low level stations also, be a minimum in the early morning hours, and a flattened maximum over the day hours. Finally, as in Ceylon and on the Indian Ocean, there may be no daily variation.

A great advance was made in 1899 by Elster and Geitel. They proved, in agreement with previous experiments of Linss, that an electrified body exposed in the open air loses its charge comparatively rapidly by leakage through the air; the leakage is more rapid the clearer and more free from dust the air may be. They showed that the phenomena were entirely in agreement with the supposition that the atmosphere contains positively and negatively charged ions free to move under the action of the electric field. An interesting account of the application of our knowledge of gaseous ions to the explanation of many of the phenomena of atmospheric electricity has been given by Geitel.[2]

Charged conductors exposed in the open air are found to lose 1 or 2 per cent. of their charge or more per minute; the leakage from negatively charged bodies is often somewhat greater than that from positively charged bodies; this difference is especially great on mountain peaks, where a negative charge may be neutralised many times as fast as a positive one, indicating an excess of positive ions. Ebert[3] found in balloon ascents an increased rate of neutralisation in the upper atmosphere as on mountain peaks, but without any marked difference between positive and negative leaks. Many observers, especially in Germany, have lately been carrying out measurements of this "Elektricitätszerstreuung."

There have, however, been very few absolute measurements from which the number of ions present per c.c. in the open air could be determined. Measurements of this kind have been made by Ebert and by Rutherford and Allen. The latter observers found (*Phil. Mag.*, December, 1902) for the number of ions per c.c. of air drawn in from outside their laboratory values which on certain occasions were as low as ·30 per c.c., the charge carried by each ion being about 3×10^{-0} electrostatic units, according to recent determinations by J. J. Thomson (*Phil. Mag.*, March) and by H. A. Wilson (*Phil. Mag.*, April). Rutherford and Allen also showed that the velocity of the ions of the free atmosphere under a given strength of field was approximately the same as that of the ions produced by Röntgen and Becquerel rays, being about 1.4 cm. per second for a potential gradient of a volt per cm.; we are probably therefore justified in assuming an identity in other properties also. With the above values for the number of ions and their velocity, the charge on the ground should be neutralised at the rate of about a half per cent. per minute.

In connection with the question of the origin of the ions in the atmosphere, some remarkable phenomena have to be considered. Even in dust-free air in a closed vessel in the dark there is a continuous production of ions, generally at rates not differing greatly from 40 per c.c. per second, if we interpret the measurements in the light of the most recent determinations of the ionic charge. It has, however, been shown by McLennan and Burton,[1] and by Strutt (NATURE, February 19), that the greater part of the effect is due to the walls of the vessel, that ordinary substances in varying degrees resemble radium in being radio-active and producing radio-active emanations, the effects, however, being of incomparably smaller intensity. The two first-named experimenters also found that a part of the ionisation is due to an extremely penetrating radiation from sources outside the vessel. Rutherford and Cooke (NATURE, April 2) have obtained a similar result. Elster and Geitel found that negatively charged bodies exposed in the open air become temporarily radio-active, just as they do when exposed to the emanations from radium or thorium. Vessels in which freshly fallen rain or snow have been evaporated to dryness show a similar temporary radio-activity.[2] The atmosphere apparently contains an emanation like that from radium. Air pumped out of the ground shows these effects to an abnormally marked degree, as Elster and Geitel have proved. The surface of the ground, and to a still greater extent the exposed portions of trees, must, it will be observed, under normal fine weather conditions become radio-active in virtue of their negative charge, and produce, therefore, an abnormal amount of ionisation in the air near them.

It is probable, in the light of Lenard's experiments, that sunlight ionises the air which it traverses, especially in the upper atmosphere, while it is still strong in ultra-violet rays.

The conductivity of the air increases in a sense the difficulty of the problem of the origin of the earth's electric field. For it would seem that the electric field in fine weather regions should rapidly diminish, and in a few hours disappear; there must be some process by which the electric field is continually being regenerated. Leaving aside, however, the consideration of the origin of the electric field, we may attempt to explain its variations as due to the variations in the conditions determining its rate of destruction. Whatever increases the conductivity of the air will diminish the electric field, and *vice versâ*. Examples of the application of this principle will be found in the paper by Geitel already mentioned. To take only one, the increase in the electric field accompanying fogs (a phenomenon well shown in the Kew electrograph curves) may be explained as due to the entangling of the ions by the fog particles; the leakage of electricity under such conditions has been found by Elster and Geitel to be very slight.

In regions enjoying fine weather, if we assume the existence of a flow of electricity in the direction of the electric field, there will be a downward earth-air current; there must then be a compensating current accompanying precipitation, negative electricity being brought down in the rain, and the positive charge being left behind in the atmosphere and carried by upper air currents to other regions. There is, as we shall see later, reason to believe that an excess of negative electricity is brought down to the earth's surface by rain. It is, however, doubtful whether we can explain in this way the existence of the normal electric field at a distance from regions where rain is falling; for the positively charged upper air currents would continually be losing their charges, and we should expect a rapid falling off in the intensity of the field

[1] Chauveau, *C.R.*, vol. cxvii. p. 1069 (1893).
[2] "Ueber die Anwendung der Lehre von den Gasionen auf die Erscheinungen der atmosphärischen Elektricität." (Braunschweig, 1901.)
[3] "Terrestrial Magnetism," vol. vi. p. 97 (1901).

[1] In a paper read before the American Physical Society, December, 1902.
[2] C. T. R. Wilson, Camb. Phil. *Proc.*, vol. xi. p. 428; vol. xii. pp. 17 and 85; M'Lennan, *Phil. Mag.*, April.

with increasing distance from the region of precipitation.

We may, on the other hand, suppose that there are everywhere other influences opposing or neutralising the ion of electricity in the direction of the electric field; so that no earth-air current results. Geitel has offered an explanation of the maintenance of the electric field in fine weather based on a difference between positive and negative ions which was discovered by Zeleny. Negative ions are more mobile than positive, they travel with greater velocity in an electric field and diffuse more rapidly. In consequence a body exposed to a current of ionised air becomes negatively charged; Geitel suggests that the surface of the earth may acquire its negative charge in a similar way. The difference in the velocities of diffusion of the positive and negative ions could not, however, maintain an electric field except close to the ground, unless air currents were present to carry up the positively charged layers produced at the earth's surface.

It is quite conceivable that we may be driven to seek an extra-terrestrial source for the negative charge of the earth's surface. The study of the aurora borealis has led several observers to the conclusion that the sun emits kathode rays, which are deflected by the earth's magnetic field, and travel in helical paths round the magnetic lines of force towards the poles. It is conceivable that very penetrating rays of this type (*i.e.* negatively charged electrons) may traverse our atmosphere unabsorbed, and be stopped in the solid mass of the earth, giving to it their negative charge.

We have now to consider the electrical phenomena accompanying precipitation. As already indicated, precipitation is nearly always associated with the occurrence of negative values of the potential gradient. Heavy showers of rain, snow, or hail are accompanied by rapid alternations of high positive and high negative values of the electric field, generally too high to be measured by electrograph apparatus arranged to suit fine weather conditions. In extreme cases we have thunderstorms. There are cases of rain not associated with negative potential gradients; these are practically all cases of slight rain, generally mere wet mist or drizzle. Clouds from which rain is not falling rarely show marked electrical effects. To find by direct observation whether rain is charged with electricity is a matter of extreme difficulty. Elster and Geitel's observations appear to show that raindrops are charged, and that the sign of the charge frequently changes during a shower, negative values, however, on the whole prevailing.

The following are possible factors in the production of the intense electrical fields which accompany heavy showers.

A less degree of supersaturation is required to make water condense on the negative than on the positive ions (C. T. R. Wilson, *Phil. Trans.*, vol. cxciii. p. 289). Thus, if condensation takes place from the supersaturated condition, the drops formed are likely to be negatively charged; that the drops, formed in ionised air by expansions slightly exceeding that required to cause condensation on negative ions, are actually negatively charged has been proved by H. A. Wilson (*Phil. Mag.*, April). Since, however, each drop will only carry the very small ionic charge, the electrical effect will be small if only a few large drops are formed; if a large number of negative ions serve as nuclei of condensation, the drops will be small, and will only fall slowly relatively to the air; the resulting electric field cannot exceed that which drives positive ions downwards as fast as the negatively charged drops fall under the action of gravity. The field initially produced may, however, be strong enough to induce coalescence of drops which come in contact (Lord Rayleigh, Roy. Soc. *Proc.* xxviii. p. 406), and we may thus get drops carrying many times the charge of one ion, and large enough to fall rapidly. Strong fields may then result.

Again, we should expect (NATURE, vol. lxii. p. 149) drops falling through ionised air to become negatively charged as a result of the difference in the mobility of the positive and negative ions. This effect has, in fact, been experimentally demonstrated by Schmauss (*Ann. d. Physik*, vol. ix. p. 224).

If collisions resulting in splashing occur between raindrops (and they are likely to be frequent in the uprush of air in thunderstorms), positively charged rain may be formed. For, as Lenard has shown, when splashing of pure water occurs, as, for example, in waterfalls, the air in the neighbourhood acquires a negative, the water a positive, charge.

Apart from the Lenard effect, the splashing resulting from the collision of drops in an electric field may have large effects, either in intensifying or diminishing the electric field already existing, the action being like that of an electrostatic influence machine. The result would be to increase the intensity of the field if the splashes were thrown out from the lower portion of the combined drop. If, for example, the field were such as to produce positive electrification on the lower surface of a neutral drop, a droplet leaving the lower surface would be positively charged, and being carried upwards by the air relatively to the large drop, would add to the intensity of the primary field.

C. T. R. WILSON.

RAINFALL AND RIVER FLOW IN THE THAMES BASIN.[1]

THE Water Committee of the London County Council in December, 1902, called upon their chief engineer for a report on the diminution of the volume of water in the Thames and Lea, and his report was submitted to the Council in February. It deals briefly with the geology of the Thames and Lea basins so far as geology affects waterworks engineering, and in greater detail with the rainfall and the flow of the streams. The general result of the inquiry is thus stated:—

"For the past twenty years there has been a decline over the Thames watershed of an annual average of nearly 2½ inches below the mean rainfall of 28.50 inches, as computed by the late Mr. Symons for the forty years 1850–89; and I may add that this diminution has become more accentuated during the last five years. This decline is reflected in the diminished flow of the river as gauged at Teddington Weir, the natural flow having fallen to an average of 1110½ million gallons daily at the intakes for the 20 years compared with 1350 million gallons over the 1850–89 period, showing a loss to the river of 239½ million gallons per day. As the diminished rainfall of 2½ inches equals 105 million gallons per day (after making an allowance for evaporation, &c., of roughly 70 per cent.), and the above diminished flow of 239½ million gallons shows a difference from this of 134½ million gallons daily, it would appear as though the condition of the river was becoming more acute, inasmuch as more rainfall would be required year by year to produce the long-period average rate of flow; in fact, what this means is that the percentage of total rainfall which reaches the river is diminishing as well as the total rainfall itself. Of course, against these facts we have the possibility of a long series of wet years, which

[1] London County Council. Shrinkage of the Thames and Lea Report by Maurice Fitzmaurice, C.M.G., Chief Engineer. Pp. 18; plates. (London: P. S. King and Co., 1903.)

may bring back the state of affairs which existed on the average during the long period mentioned."

The fact that we are at present in a period of relatively low rainfall is, of course, well known, and as regards the Thames Basin, the following table is quoted, giving the average annual fall deduced from twenty-four well-distributed stations:—

Year	Inches	Year	Inches	Year	Inches	Year	Inches
1883 ...	28·41	1888 ...	28·45	1893 ...	22·08	1898 ...	22·07
1884 ...	22·90	1889 ...	25·65	1894 ...	32·33	1899 ...	24·78
1885 ...	29·15	1890 ...	22·81	1895 ...	26·32	1900 ...	27·88
1886 ...	31·07	1891 ...	33·31	1896 ...	25·82	1901 ...	23·47
1887 ...	21·32	1892 ...	23·02	1897 ...	27·79	1902 ...	21·91

The report points out that the mean rainfall for the ten years 1883–92 was 26.60, and for the ten years 1893–1902 it was 25.44, or more than an inch less. But it is not clearly pointed out that the means of the four consecutive periods of five years give the respective values 26.57 in., 26.65 in., 26.87 in., and 24.02 in., in other words, that on the whole the rainfall was increasing slightly for fifteen years, and fell sharply in the last five. Nor is attention called to the fact that the average rainfall of 28.50 inches for the Thames Basin was arrived at by Mr. Symons in 1893 from the consideration of a much larger number of stations than the twenty-four on which the subsequent values are based, for the ten years 1880–89, which period Mr. Symons showed probably gave the same mean value as the long period 1850–89. It is probable that the latter figures represent the average rainfall of the basin as accurately as so small a number of stations can, and they are at least comparable *inter se*, but it is by no means so sure that they can fairly be compared with the earlier mean value obtained by the consideration of a much larger number of stations. In fact, we are not inclined to look upon the decline in the rainfall as quite so serious as it appears to be from the report, and we are confident that in the course of time, and probably in a comparatively short time, the fall will again reach the average.

The report shows plainly that the diminution in the flow of the Thames (and the same holds good of the Lea) is greater than the diminution of the rainfall. Theoretical considerations suggest that this is what should occur, for the amount of water absorbed by vegetation must be approximately constant, and in a dry year evaporation is usually more active than in a wet one, while, when the water-level in the pervious rocks is lowered, the flow of springs cannot respond to the rainfall with the promptitude usual when the rocks are saturated.

It is a matter of regret that hydrology, as applied to the rivers of the whole British Isles, has not been taken up by any Government department. This report of the County Council shows the interest of the problems involved, and it may be that a more systematic treatment of statistics of rainfall and river-flow would answer the questions which is suggests.

HUGH ROBERT MILL.

ARCTIC GEOLOGY.

As the report on the geological observations made during the recent Polar expedition of the *Fram*, recently read before the Royal Geographical Society by Mr. P. Schel, of which we have received a separate copy, is only a preliminary one, and the geological terms employed require some revision to make them intelligible to an English reader, a brief notice may suffice, though evidently the results will be very valuable. Under Captain Sverdrup's leadership, Ellesmere Land was crossed, part of its southern and its western coast was traced, with the corresponding side of Grinnell Land, and journeys were made round Axel Heiberg and Ringnes Islands. The collections obtained, which were often considerable, show that the region explored, with the newly discovered islands, consists of formations which were known to occur on the two sides of Smith Sound and on the long chain of islands extending on or near the seventy-fifth parallel from North Devon to Prince Patrick Island, viz. a foundation of crystalline Archæan rocks, largely granitoid, followed by sedimentaries the oldest of which are of Cambrian age, the part immediately following the Archæan being occasionally, as might be expected, an arkose. In some places representatives of the Ordovician and Silurian occur, and, as in the other islands, Devonian and Carboniferous, including the representative limestone, are extensively developed. Mesozoic formations are represented, but apparently on no great scale, and large masses of sandstone, with lignites and shales, are identified by their plant fossils as Tertiary (Miocene or perhaps rather earlier), as in Greenland. In parts of Ellesmere Land and Heiberg Island are various eruptive rocks, porphyrites and diabases, cutting the Archæan and the older sedimentaries. Basalts and dolerites occur in Grinnell Land intrusive in Mesozoic strata, and surface lavas and somewhat similar rocks overlie Carboniferous rocks in Heiberg Island. They are older than the Tertiary shale mentioned above. The region has occasionally been much faulted, and locally crushed up against a "horst" of Archæan rock. It has also been affected by earth movements of late date, indicated by raised beaches and marine terraces, which are at various elevations up to nearly 600 feet, and so prove that the land has risen. There are no large masses of inland ice or signs of glaciers having formerly been on a much more extensive scale than at present. This is probably due, at any rate partly, to a rather small precipitation.

J. V. LABORDE (1830–1903).

DR. LABORDE (Jean Baptiste Vincent), who died recently at the age of seventy-two, was born at Buzet (Lot et Garonne), and received a good education at the Lycée of Cahors, after spending some time in a boarding-school at Casteljaloux. To satisfy his natural bent for medical studies he went to Paris, without any resources, and, in order to provide for his livelihood and his studies, he was obliged to give private lessons. However, he managed to be appointed *externe des hopitaux in* 1854, in the same promotion as Lancereaux, now president of the Académie de Médecine. Four years later, he obtained the *internat*, in which capacity he spent four years more in the hospitals of Paris, after which he was graduated doctor médic. for his thesis on "La Paralysie Infantile" (1864). Meanwhile he had obtained the gold medal of the hospitals, the Corvisart prize, and another prize from the Société Médicale des Hopitaux, and, lastly, in the very year in which he got his doctor's degree, the Godard prize, awarded by the Société Anatomique de Paris.

In 1872 Laborde gave up pure medicine to devote himself to scientific works, particularly to physiology, giving to his researches a solid and safe basis, by means of the experimental method. At first only an assistant to Prof. Béclard, he was soon appointed chef des travaux de physiologie at the Faculté de Médecine, and for many years the demonstrations he gave in his laboratory were attended by numerous pupils. It was in the course of this period that he published the

greater part of his works, always seeking in physiology pathological deductions for the use of practitioners.

As regards pure physiology, he studied the acid of the gastric juice, trying to show that it never existed uncombined (1874–77), the rhythmical function of the heart and its development in the embryo (1876), and more especially the function of the central nervous system, and of the bulb in particular (1877–1880). In this way he showed the existence of two bulbar centres, one acting upon breathing (it was the centre of Le Gallois and Flourens), the other upon the cardiac muscle, which clearly explained the two possible causes of death, either a stop of the respiratory movements with persistence of the beating of the heart or *vice versâ*. He showed also the functional association of the eyes in the binocular vision, owing to the narrow connections between their motor nerves. As regards the physiology of the nerves, again, he revealed the existence of the tractus of crossed hemianæsthesy, published a few notes on the excitability of the nervous centres, the reflex movements, the functions of the semicircular canals (1881), and, lastly, a refutation of the theory which made the cerebellum the seat of muscular strength.

Not less numerous are the works that he published upon experimental and comparative pathology.

But his special study was experimental physiology applied to therapeutics and toxicology; he published works on the properties of many substances, such as the narceine (1866), which he considered as the best sedative of the nervous system; the bromides, the soothing influence of which he investigated (1867–1869); the eserine or alkaloid of the Calabar bean (1869); propylamine (1873); aconitine, the advantages of which he showed as a sedative of sensibility (1875); colchicine, sparteine, boldo, salts of strontium, &c.; lastly, in 1877, he published a study on the alkaloids of cinchona, which he named in the following order, according to their poisonous qualities: Cinchonine, cinchonidine, quinidine. In fact, he made a special study of poisons in general, animal as well as mineral, natural as well as artificial.

In concluding this cursory view of Laborde's works, we cannot do better than mention his ingenious method of the rhythmical tractions of the tongue, which was sufficient to make the name of its inventor known throughout all the world. There is no need to expatiate on this most simple and efficient process of setting the respiratory reflex to work. It is known and used everywhere, and it has called back to life numbers of apparently drowned or suffocated people.

In fact, Laborde was not only a savant, but a great philanthropist, and this quality, together with his profound knowledge of toxicology, brought him to the front as one of the best qualified in the controversy raised recently on the question of alcoholism.

For this reason, Laborde, who had been a member of the Académie de Médecine since 1887, was trusted by this learned body with the report on the essences to be forbidden as noxious, which the Government had required from them. In this work he exhausted what strength was left to him. He strenuously defended every one of his arguments against the objections of his colleagues, and at last succeeded in making them adopt every item of his report. But the work proved too much for him, and he died on April 5. He was vice-president of the Society of Biology, director of the Laboratory of Anthropology at the École des Hautes Études since 1893, and professor at the School of Anthropology. He was besides one of the oldest and ablest scientific journalists. He started *La Tribune Médicale*, a periodical open to all young medical men, which he edited to the last.

He was one of the few French savants who did not belong to the Legion of Honour. Of course, the decoration was several times offered to him, but he thought it a distinction which should be exclusively military, and he never allowed his actions to contradict his opinions.

J. Deniker.

NOTES.

A meeting of the council of the International Association of Academies is being held this week at the rooms of the Royal Society, that society being the directing academy of the association for the three years' period ending with 1904. The meeting will be attended by delegates from nearly all the principal learned academies of Europe, and will discuss several matters of importance to international science and philosophy, preparatory to the meeting of the general assembly which is to be held in London next year. Representatives of both sections of the association, the natural science section, and the history and philosophy section, will attend the council. In connection with the meeting of the council there will be on Friday a meeting of a special committee appointed to deal with a proposal for the establishment of an international organisation for the investigation of the anatomy of the brain. The foreign delegates were to be received by the president and fellows of the Royal Society at Burlington House on Wednesday evening as we went to press.

The reply given by Mr. Balfour in the House of Commons on May 26, in answer to a question as to what the Government proposed to do to ensure the safety of the National Antarctic Expedition, was a rebuke which should not be received in silence by the joint Antarctic Committee. Mr. Balfour said:—" The Government are prepared to contribute to the relief of the officers and men on board the *Discovery*, which is now ice-bound in the Antarctic seas. The course taken by the two learned societies responsible for the expedition in respect to the contribution of money and men made by the Government is greatly to be regretted. I have always leaned towards the principle of extending the very limited aid which the British Government have been accustomed to give towards the furtherance of purely scientific research; but such action can only be justified so long as the Government are able to feel absolute confidence that the scientific bodies approaching them have placed before them all the information in their possession as to the estimated cost of their proposed action, and the limits within which they intend to confine it. That confidence has been rudely shaken by the present case." This statement has naturally received much attention, and the Antarctic Committee cannot permit the charges it contains to pass without reply. The two learned societies referred to are the Royal Society and the Royal Geographical Society, and the management of the expedition is in the hands of a joint committee of these bodies. From the beginning, however, the Royal Geographical Society has exerted a preponderant influence in the organisation of the expedition, and the Royal Society has yielded to it against the advice of its own representatives. When vital matters connected with the conduct of the expedition were in dispute in 1901, we on several occasions criticised the methods adopted, and regretted that the Royal Society had not taken a firmer position. Because the council of the Royal Geographical Society would not accept the recommendations of the joint committee, the Royal Society allowed itself to be overruled, though Sir Archibald Geikie, Prof. E. B. Poulton and Mr. J. Y. Buchanan objected to the surrender. The whole story was told in a letter sent by Prof. Poulton to fellows of the Royal Society, and published in Nature of May 23,

1901. This protest was, however, disregarded, with the result that the Society now finds itself held responsible for management which has really been left to the geographers. The *Daily Mail* has published several articles in which the joint committee is severely handled, and the facts disclosed as to the estimated and actual costs of the expedition are, to say the least, such as will not encourage the public to believe in the foresight and business capacity of men of science.

THE condition of the German Antarctic Expedition which, under the command of Dr. von Drygalski, left Germany in August, 1901, is causing great anxiety, and hurried preparations are being made for the dispatch of a relief expedition this summer. It will be remembered, a correspondent of the *Pall Mall* remarks, that a station was erected on Kerguelen Island in January, 1902, which was intended to serve as a place of observation and as a base for the expedition ship *Gauss*, which was to penetrate much farther south. Those who were at the station, however, suffered terribly from the climate, and then were attacked by beri-beri, which appears to be endemic in that part of the world. This malady carried off the greater number of those who were afflicted with it, among them being Dr. Enzensperger, the meteorologist. The *Gauss* sailed south, but as nothing has been heard of her for a long time it is feared that she is lost, and doubts have been expressed that any of her present officers and crew will ever be heard of again. An attempt is, however, to be made to find them. The matter was discussed in the Reichstag a few days ago, and about 25,000*l*. was unanimously voted for a relief expedition. Preparations for departure will not be begun until the middle of next month—the latest time, according to scientific opinion, that the *Gauss* could by any chance make her way out of the vast fields of ice over which the terrible severity of an Antarctic winter is now spreading.

THE fifth International Congress for Applied Chemistry is being held in the Imperial Diet Building at Berlin, under the presidency of Prof. Dr. Otto N. Witt. About 2200 members, accompanied by more than 300 ladies, are attending the Congress, at which the European States and several other States are represented by official delegates. The chief British societies, that is, in addition to the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry, the Society of Public Analysts, the Federated Institute of Brewing, the Royal Societies of London and Edinburgh, the Iron and Steel Institute, the Royal Institution, the British Association and other bodies, nominated delegates for the organising committee. The Congress will deliberate in eleven sections and three subsections. The German Electrochemical Society, which last year adopted the name of German Bunsen Society for Applied Physical Chemistry, will also hold its annual meeting at Berlin during this week, and will take charge of the tenth electrochemical section. This section, however, will meet in the Physical Institute of the University of Berlin. The congress offices, so far at 31 March Str., Charlottenburg, will be removed to the Imperial Diet Building (Reichstags-Gebaüde) on June 2, and a post office has been opened in this building for the convenience of members. There are 350 papers and reports to be read. The great electrical works of Berlin and some other works will be thrown open to members, but no chemical works apparently. The city of Berlin will entertain the Congress, and an excursion to the Havel Lakes has been arranged for Sunday, June 7.

THE proceedings of the International Telegraph Conference, at which nearly fifty different States are represented, commenced last week, and will continue day by day during this month. The proceedings are private. Mr. J. C. Lamb, the principal delegate of Great Britain, has been elected president of the conference, and Messrs. J. Ardron and P. Benton vice-presidents. This is the ninth conference which has been held; at the last the cable companies have been represented as well as the various States. In addition to the business of the conference, dinners and other entertainments have been arranged in connection with it; a dinner was given last week by the Submarine Telegraph Companies at the Hotel Cecil, Sir J. Wolfe-Barry presiding, and nearly 500 guests being present. The president of the Institution of Electrical Engineers entertains the delegates and the Institution at a concert at the Albert Hall on June 11, and the conversazione of the Institution will also be held during the sitting of the conference.

MR. MARCONI is reported to have said on his return to England last week that it will be another six weeks before Transatlantic communication will be resumed. The precise nature of the breakdown has not been published. The American company proposes to extend greatly the system in America by establishing new stations in New York and on the great lakes. It is also stated that the report that Mr. Marconi was suffering from nervous breakdown and would have to take a prolonged rest is unfounded.

THE council of the Institution of Electrical Engineers has received and accepted an invitation from the American Institute of Electrical Engineers to visit the United States in 1904. The McGill University, of Montreal, has invited the two Institutions to hold a joint meeting in their building at this time. The invitations, both from the American Institute and the McGill University, are couched in the most cordial terms, and the council hopes that it may be possible to arrange not only for a visit to the eastern States of America and to the St. Louis Exhibition, but also for the proposed joint meeting in Canada.

THE report of the council of the Institution of Electrical Engineers, adopted at the annual general meeting held on May 28, is a record of real scientific activity and progress. The Institution is exerting the best of influences upon electrical science, and its work and scope are rapidly extending. Mr. Robert Kaye Gray has been elected president in succession to Mr. Swinburne. A new local section has been formed with its centre at Leeds, embracing the whole of Yorkshire with the exception of Middlesbrough and the Cleveland district, which were already included in the area of the Newcastle local section. The council has awarded the following premiums for papers and communications:—the Institution premium, value 25*l*., to Dr. J. A. Fleming, F.R.S., for "Photometry of Electric Lamps"; the Paris Electrical Exhibition premium, value 10*l*., to Mr. M. B. Field, for "A Study of the Phenomenon of Resonance in Electric Circuits by the Aid of Oscillograms"; two extra premiums, value 10*l*. each, one to Messrs. A. D. Constable and E. Fawssett jointly, for "Distribution Losses in Electric Supply Systems"; and the other to Dr. W. M. Thornton, for "Experiments on Synchronous Converters"; an original communication premium, value 10*l*., to Messrs. A. Russell and C. C. Paterson, for "Sparking in Switches." Students' premiums have been awarded to Messrs. J. Griffin, F. J. Hiss, E. Fisher, A. G. Ellis, and T. H. Vigor. Salomons scholarships, value 50*l*. each, have been awarded to Mr. G. B. Dyke, of University College, London, and to Mr. H. W. Kefford, of the Central Technical College. The award of the David Hughes scholarship, value 50*l*., has been made to Mr. W. H. Wilson, of King's College, London.

It has been decided to christen the new society of electro-chemists "The Faraday Society," the object of the Society, as stated in a subtitle, being to promote the study of electro-chemistry, electrometallurgy, chemical physics, metallography, and kindred subjects. It is proposed to start work at once by beginning a half-session on July 1, the first ordinary meeting being fixed for June 30; the papers to be read will be announced in due course. Arrangements have been made to publish the proceedings in the *Electro-chemist and Metallurgist*, which will be issued free to members; the papers will be circulated before being read, a plan which it is hoped will improve the discussion upon them. It is also hoped that it will be possible to supply members with the *Transactions* of the American Electro-chemical Society, either free or at a very small cost. The first president is Mr. J. W. Swan, F.R.S., and the vice-presidents are Prof. Crum Brown, Lord Kelvin, Sir O. Lodge, Dr. Ludwig Mond, Lord Rayleigh, Mr. A. Siemens and Mr. J. Swinburne. A set of rules has been drawn up by the council; these and any other particulars can be obtained from the secretary, Mr. F. S. Spiers, 82 Victoria Street, S.W. We wish the Society all success.

We regret to have to announce that Dr. A. A. Common, of Ealing, died very suddenly on Wednesday morning last.

Sir William Ramsay, K.C.B., F.R.S., has been elected a corresponding member of the Academy of Sciences of Vienna.

The presentation of the Hofmann medals to M. Henri Moissan and Sir William Ramsay is to take place at the Hofmann-Haus, Berlin, to-day, June 4.

The annual conversazione of the Society of Arts will take place at the Royal Botanic Gardens, Regent's Park, on Tuesday, June 30.

It is expected, says *Science*, that the International Electrical Congress will be held at St. Louis, during the week beginning September 12, 1904. It will immediately precede the International Congress of Arts and Sciences.

At the anniversary meeting of the Linnean Society on May 25, Prof. S. H. Vines, F.R.S., was elected president for the ensuing year. The Linnean medal was presented to Dr. M. C. Cooke.

According to a Reuter message from Paris on May 30, a telegram from Fort de France, dated May 28, states that the volcano of Mont Pelée is again showing activity, and that the Council-General of Martinique is urging the evacuation of the whole of the north side of the island.

According to a Press despatch from Washington, dated May 13, the executive committee of the Carnegie Institution reports that the entire sum of 40,000*l.* allotted to grants for original research has been distributed, and that of the 8000*l.* set aside for publications to be made this year, 4000*l.* has been assigned to special publications. No more grants for researches will be made until after the next meeting of the board of trustees, which will be held in December.

A terrific tornado passed over the southern portion of Gainsville, Georgia, at noon on Monday, June 1, destroying several large buildings and killing sixty-four persons. The track of the tornado was about one hundred yards wide, and the damage done was confined to it. The storm came with great suddenness, and within a couple of minutes the two upper stories of a four-story brick-built factory were carried away to distances of hundreds of feet. During the tornado deep darkness prevailed, and the air was hot and oppressive. Five minutes later the sun was shining.

Extraordinary rains in parts of the United States have caused great damage and loss of life by floods in the Indian Territory, Oklahoma, Kansas, Missouri, Nebraska, and Iowa. At North Topeka, Kansas, seven thousand out of the ten thousand inhabitants left the city on May 30 to escape the deluge. One hundred and fifty persons are known to have been drowned. The rescued say that the whole of North Topeka was flooded on Friday faster than the people could get away. On May 30 the level of the Kansas River rose at the rate of three inches an hour. On June 1 the Missouri River was thirty feet above low-water mark at Kansas City, and was rising rapidly.

On Saturday afternoon, May 30, and following night London was visited by two violent thunderstorms. Storms of a destructive character, resulting in loss of life, also occurred over a great part of England, especially in the Thames Valley, and were apparently due to the passage of small cyclonic depressions moving slowly from south-east to north-west. Heavy downpours of rain accompanied or followed both storms, but its intensity varied considerably; about an inch and a half fell during the first storm in one of the southern suburbs of London, while at a distance of a very few miles, where the thunder and lightning appeared to be equally violent, the fall only amounted to a few tenths of an inch. The heat was oppressive; near London on Whit Monday the thermometer in the screen rose to 83°, and the weather was exceptionally brilliant in the south and east of England generally, but dull and cool in the north and west.

The *Times* states that the master of the trawler *City of Lincoln*, which arrived at Kirkwall on June 1 from Iceland, reported that on the night of May 27, off the south-east coast of Iceland, a volcanic eruption was observed a considerable distance to the eastward, probably at Mount Hekla. Dust fell on the deck of the trawler, and the sea was discoloured to a distance of about thirty miles from the island.

A Reuter message from Constantinople on May 26 states that belated reports have been received of the earthquake at Van on April 29, by which the town of Melazgerd was totally destroyed, with its entire population, numbering about 2000 persons. More than 400 houses in neighbouring villages collapsed. A somewhat severe shock of earthquake was felt in Constantinople on the morning of May 26, but no damage was done. Further particulars of the earthquake at Van are contained in a despatch from His Majesty's Consul at Erzerum. The villages of Patnotz, Hadjili, Mollah Ibrahim, Zoussicko and Molla Mustapha, were completely destroyed with the exception of the mosque, school and two houses. Seventeen other villages have been partially destroyed. In Sipoki the villages of Mollah Hassan, Berdav, Mirzeh, Kara Khelil Alia have been completely destroyed, and eight other villages partially destroyed. It would appear that the centre of the seismic disturbance was in the neighbourhood of Mount Sipan, and the area of its greatest violence extended along the valley of the Eastern Euphrates, covering the Kazas of Boulanyk and Melazgerd, and the Patnotz district.

As already announced, the autumn meeting of the Iron and Steel Institute will be held at Barrow-in-Furness on September 1–4, under the presidency of Mr. Andrew Carnegie. The programme will embrace visits to works, docks, and iron ore mines, and excursions will be arranged to the Lake District and to Blackpool. A detailed programme will be issued when the local arrangements are further advanced. This programme will contain a list of the papers that are expected to be read.

THE twenty-first congress of the Sanitary Institute will be held at Bradford on July 6–11. The inaugural address to the congress will be delivered by the president, the Right Hon. the Earl Stamford. Numerous sectional meetings will be held, the sections with their presidents being as follows:—(1) Sanitary science and preventive medicine, Prof. T. Clifford Allbutt, F.R.S.; (2) engineering and architecture, Mr. Maurice Fitzmaurice, C.M.G.; (3) physics, chemistry and biology, Prof. C. Hunter Stewart. On July 8 there will be conferences of those engaged in the various branches of practical sanitary science, and in the evening a conversazione and reception by the Mayor of Bradford. The concluding day will be devoted to excursions.

THE Physical Society has for several years held its meetings at Burlington House, but the fellows have been given notice that a change is contemplated. It is proposed to hold meetings on the second and fourth Fridays of the month alternately in the afternoon and the evening at the Royal College of Science, South Kensington. The council trusts that convenience and equipment available when the Society meets in a physical laboratory will encourage fellows to illustrate their papers by experiments, and thus add to the interest of the meetings. The council has also under consideration the formation of a student class in the Society. This matter will shortly be brought forward at a special general meeting.

MR. R. S. EARP writes from Buckfastleigh, South Devon, to say that on comparing the results of Prof. Thorpe's analysis of the dust of "red rain" (p. 53) with his own, the chief dissimilarity was found in the amount of organic matter. This may be explained by the fact of Prof. Thorpe's analysis being of the sediment only of the rain, whereas Mr. Earp's was of the rain itself, or rather of the solid constituents of the rain. The rain collected did not clear itself even on long standing, the supernatant liquid being emulsion-like in appearance. Mr. Earp concludes "that the greater portion of the organic matter would exist suspended in the fallen rain, and so would not appear in the result of Prof. Thorpe's analysis."

THE scientific balloon ascents on April 2 were participated in by France, Germany, Austria, Russia, and Blue Hill, U.S., and were made by means of manned and registering balloons, and kites. At Trappes the registering balloon burst at 8550 metres; minimum temperature $-47^{\circ}\cdot0$ C. (at starting $0^{\circ}\cdot8$). At Itteville (Paris) the ascent was made in the evening; temperature $-54^{\circ}\cdot0$ at 9560 metres (at starting $8^{\circ}\cdot0$); an altitude of 12,760 metres was reached. At Strassburg a height of 10,000 metres was attained; minimum temperature $-44^{\circ}\cdot4$, at starting (5h. a.m.) $5^{\circ}\cdot7$. At Berlin one of the several balloons dispatched reached 10,400 metres; at 8380 metres the temperature was $-42^{\circ}\cdot0$ (at starting $2^{\circ}\cdot0$), while another, started two hours earlier (4h. 57m. a.m.), recorded $-47^{\circ}\cdot8$ at 8670 metres. At Blue Hill a kite reached 3067 metres, temperature $-6^{\circ}\cdot2$; at the same time the temperature at the observatory was $8^{\circ}\cdot1$ (height 159 metres). Atmospheric pressure was fairly uniform over Europe on the day of the ascents, and the type of weather was generally cyclonic in character.

IN a paper read before the R. Accademia delle Scienze dell' Istituto di Bologna on January 11, Prof. A. Righi describes experiments on the ionisation of air by an electrified point. Some striking results depending on the motion of the ions along the electric lines of force were obtained. A sheet of ebonite backed by a metal plate was fixed in front of a point discharge, and between them was placed a wire gauze screen, which closed an aperture in a metal case surrounding the discharge. A spark from a Leyden jar to the metal plate produced for a short time a powerful electric field traversing the ebonite plate and the air space between it and the gauze. A well-defined image of the wire gauze was then developed upon the ebonite by treating it with a mixture of powdered sulphur and red lead, which made visible the portions of the ebonite to which the ions had imparted a charge. The "electric shadow" of the wire remains free from charge.

A NEW form of stereoscope for X-ray work is described by M. T. Guilloz in a recent number of the *Journal de Physique*. A single X-ray tube is used, being so mounted that it can be rapidly oscillated between two positions. A cam rotating at a speed of about 300 revolutions per minute is used to oscillate the tube; this cam is cut so that the time taken in moving from one position of rest to the other is about 1/10th of the time of rotation. Two radiographic images of the object under examination are thus formed on the screen which are displaced by an amount varying as the amplitude of oscillation of the tube and its distance from the screen. Two shutters, controlled electromagnetically by the oscillating apparatus, allow the right eye to view one image and the left the other, vision being entirely cut off during the time the tube is changing its position. There results, naturally, from the combination of these images an apparently solid reproduction of the object. It is claimed that the method is superior to those employing two tubes, or a tube with two anti-kathodes, as in these cases it is always difficult to obtain equal effects from both tubes or anti-kathodes. It is also stated that the tubes used by the author were not injuriously affected by the vibration.

THE Canadian Department of the Interior has issued a clearly printed map of Manitoba on the scale of an inch to $12\frac{1}{2}$ miles. It will be useful to those desirous of taking up land in the country.

PARTICULARS of the mode of occurrence and removal of a carcase of the mammoth which had been discovered in 1901 in the province of Iakousk, in Siberia, are contributed with illustrations by M. L. Elbée (*La Nature*, May 23). The remains were half embedded in the snow and ice, and there were still preserved the eyes, the mouth, and even the stomach. Measurements showed that the animal was about 3 metres in length and 2 metres in height, and must have weighed about 1000 kg. The specimen has not yet been exhibited in public owing to the great difficulties experienced in preserving the skin.

IN the annual report for 1902 of the State Geologist of New Jersey, Mr. H. B. Kümmel, there is an account of the copper deposits of the State, by Mr. W. H. Weed. Copper minerals occur at many localities in the crystalline rocks and in the Triassic Red Sandstones, but only in the Red Sandstones are they of economic value. In these rocks the ores are almost always associated with basalt, dolerite, and diabase of very uniform chemical composition, and from these basic igneous rocks, in the opinion of Mr. Weed, the copper ores have been derived.

IN the account of the embryogeny of Zamia which Profs. Coulter and Chamberlain present in the *Botanical Gazette*, they show that during this stage of development the features of Zamia are intermediate between those presented by Cycas and the Conifers.

IN the Philippine Islands Government laboratories were organised by the United States authorities in 1901, and Dr. R. P. Strong was appointed director. The first annual report gives evidence of much work carried out under un-

favourable conditions in temporary laboratories. The work of the biological department is mainly pathological, and is concerned with the study of Asiatic cholera and other tropical diseases. New laboratory buildings are announced, in which special facilities will be offered to foreign men of science who wish to undertake research work.

THE Californian red wood, *Sequoia sempervireus*, forms the subject of a *Bulletin* issued by the U.S. Department of Agriculture. Natural reproduction by seedlings is rare, as these require plenty of light, but the writer, Mr. Fisher, shows that effective second-growth is produced by sucker shoots. A brown rot disease affecting the standing tree is described by Prof. von Schrenck, but the cause of the disease which is said to arise in the heart wood has not been determined. Another *Bulletin*, by Mr. Foley, affords good proof of the value of careful lumbering as adopted on the Sewanee University Estate, Tennessee.

IN addition to some half-dozen short excursions to places of interest of easy access, and one long excursion to the north Donegal coast, beginning on July 10, which it has arranged, the Belfast Naturalists' Field Club is offering for competition during the session ending March 31, 1904, nineteen prizes, generally of the value of one pound, and in other cases of ten shillings, for collections of different botanical, geological and zoological objects. The prizes are to be in books or suitable scientific objects. Among the collections asked for may be mentioned the best herbarium of local flowering plants, representing not less than 150 species, with notes on variations adapting the plants to special environments; the algæ of Larne Lough, with an account of distribution; the algæ of Belfast Lough; fossils from the Rhætic and Lias of Ulster; and the best set of twelve photographs illustrative of any one branch of Irish archæology. A prize is also offered for the best original account of the habits of any marine annelid.

AN interesting interim report upon Cape horse-sickness has been published by Dr. Watkins Pitchford, the Government bacteriologist of Natal. In some respects this disease resembles human malaria, for it especially attacks horses kept on low-lying marshy ground, and those animals left to graze all night. In affected districts horses may be moved during the day without contracting the disease. Dr. Pitchford now suggests that a mosquito, probably of the genus Anopheles, is responsible for the conveyance of the infection. He has stalled horses by night in stables protected by wire gauze, or by a smoky atmosphere, in an infected district, with the result that they all remained perfectly well; whereas horses kept around and similarly treated, with the exception of the protection afforded by the wire gauze or smoke, succumbed. He therefore believes that it is established that horses protected from the attacks of winged insects enjoy immunity from horse-sickness.

THE January issue of the *Proceedings* of the Philadelphia Academy contains a list of the polycistid gregarines of the United States, by Mr. H. Crawley, and an account of the habits of spiders, by Dr. T. H. Montgomery.

WE have received three parts (Nos. 10–12) of Manchester Museum *Notes*, in two of which Prof. W. B. Dawkins deals with the older rocks of the Isle of Man, while in the third he describes certain iron implements found in the old "camp" in Bigbury Wood, near Canterbury. These implements prove that the camp belonged to the prehistoric period, and from this it is inferred that the well-known "Pilgrims' Way," which traverses such a large extent of country in the south of England, likewise dates from that epoch.

THE greater portion of the May number of the *Quarterly Journal of Microscopical Science* is occupied by an important paper from the pen of Mr. H. J. Hansen, of Copenhagen, on the genera and species of the myriopod order Symphyla. The first known species was described 138 years ago, and the order is now known to contain at least 100 species. The other contents of this part include an account of the body-cavity and nephridia of the Actinotrocha larva, by Mr. E. S. Goodrich; a description of various acorn-worms (Enteropneusta) from Madras, by Mr. R. K. Menon; and a notice of the radiolarian *Planktonetta atlantica*, by Dr. G. H. Fowler. The latter organism is distinguished from all other members of its group by the possession of a float, a diaphragm, and a single bundle of tubes of communication.

THE *Times* of May 19 contains a notice of the results of the survey of the fishes of the Nile, undertaken by the Egyptian Government, in cooperation with the trustees of the British Museum, which has just been brought to a conclusion, after three and a half years' hard work by Mr. W. S. Loat, who has had charge of the operations. The scheme was due to the initiation of the late Dr. John Anderson, and although, so far as the discovery of new species is concerned, its results have been disappointing, it has yielded important information with regard to distribution. Previous to the survey, the number of species of fish known to inhabit the Nile was about 90; it is now more than 100, Mr. G. A. Boulenger having described 14 new species from among a collection of between 9000 and 10,000 specimens. Mr. Loat carried his survey far up both the Blue and the White Niles, and thus completed the work begun in the early "sixties" by Consul Petherick. It is satisfactory to learn that Mrs. Anderson has made arrangements for the publication of a volume on the fishes of Egypt in the same style as those on the mammals and reptiles.

A USEFUL manual for practical photographers, by Mr. Alfred Watkins, entitled "The Watkins Manual of Exposure and Development," has reached a second edition. The text-book is published by the Watkins Meter Company, of Hereford, and contains much information likely to prove of service to photographers who already have some acquaintance with the subject, as well as to beginners.

THE fourth edition of the "Official Guide" to the Belfast and Northern Counties Railway, which has reached us, will provide the visitor to the north of Ireland with just the information he will want. The guide is liberally supplied with maps and illustrations, and there are notes on places and objects of scientific interest. The book is published by Messrs. R. Carswell and Son, of Belfast, and costs sixpence.

A NUMBER of attempts have been made at various times to introduce standard points on the temperature scale other than the freezing point and boiling point of water, and for high temperature work, especially the standardisation of platinum resistance thermometers, Messrs. Heycock and Neville have recommended the use, as a third standard temperature, of the boiling point of sulphur. The *Zeitschrift für physikalische Chemie* for April 23 contains an account of a very careful determination, by Messrs. T. W. Richards and R. C. Wells, of the position on the international hydrogen scale of a standard temperature intermediate between the freezing point and boiling point of water. As the mean result of twenty-two determinations made with four different thermometers, it was found that the transition temperature at which the monohydrate and the dekahydrate of sodium sulphate were both in equilibrium with an aqueous solution of the salt lay at $32{\cdot}383^\circ \pm 0{\cdot}001$.

The water used was purified by distilling twice and freezing in a platinum vessel, and the sodium sulphate was crystallised until it gave a constant transition temperature.

THE additions to the Zoological Society's Gardens during the past week include a Serval (*Felis serval*) from South Africa, presented by Mr. C. H. Firmin; a Harlequin Elaps (*Elaps fulvius*) from Central America, presented by Captain J. B. Gilliat; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; a Chinchilla (*Chinchilla lanigera*) from Chili, purchased; a Japanese Deer (*Cervus sika*), a Sambur Deer (*Cervus aristotelis*), a Red Deer (*Cervus elaphus*), a Thar (*Hemitragus jemlaicus*), an American Bison (*Bison americanus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

A REPORTED PROJECTION ON MARS.—A Reuter's correspondent at Cambridge, U.S.A., states that the Harvard College Observatory at Flagstaff reports the discovery of a large projection on Mars at 3.35 a.m. (G.M.T.) on May 26. The position angle of the projection is given as 200°.

REPORT OF THE OXFORD UNIVERSITY OBSERVATORY.—From the report of this observatory for the period May 1, 1902, to April 30, 1903, just issued by Prof. H. H. Turner, we learn that of the 1180 plates which had to be measured and reduced for the Astrographic Chart, 1100 are now completed, 170 of them having been finished during the period with which the report deals.

When these measurements are completed it is proposed to undertake the measures of the plates, obtained during the opposition of 1900–1901, of the planet Eros, for the purpose of obtaining a more trustworthy value for the solar parallax, this work having been undertaken as a supplementary labour by the International Astrographic Committee.

Paragraph vi. of the report gives an account of the fortuitous discovery of Nova Geminorum, which possibly would not have been discovered at Oxford but for the fact that the first batch of plates used in photographing the Nova's region for the Chart proved faulty, and thereby rendered it necessary that this zone should be rephotographed. It was whilst photographing the zone the second time that Mr. Bellamy used the Nova as a "setting" star, thereby causing the inquiry to be set on foot, when the plate came to be measured, which led to the happy discovery that the bright star he had used in setting his instrument was a hitherto unknown object.

PERIODICITIES OF THE TIDAL FORCES AND EARTHQUAKES.—In a paper communicated to No. 3, part ii., vol. lxxi. of the *Journal* of the Asiatic Society of Bengal, Mr. R. D. Oldham, of the Geological Survey of India, discusses the relations between the periodicity of the earthquake shocks recorded by a seismograph set up at Shillong, Assam, during the period August, 1897, to December, 1901, and the periodicity of the tidal forces obtaining at that place during the various relative positions of the sun and moon.

After deducing the reasons for expecting the shocks to appear at certain times during the day and night when the tidal force is at a maximum at the place of observation, Mr. Oldham sets out the recorded shocks in a series of tables and curves. On examining these it is clearly seen that there was a real and a very large variation in the diurnal distribution of shocks in Assam during 1897–1901, their greatest frequencies occurring at 10–11 p.m. and 6–7 a.m., and superimposed on this regular but unexplained variation there was a smaller one, which appears to have been due to the tidal stresses set up by the attraction of the sun. If this latter variation is really due to tidal stress, it then appears that the horizontal component of the stress is much more effective than the vertical component, whilst the effects are more dependent on the rate and range of the stress than on its amount.

Mr. Oldham points out that these results are purely provisional, dealing as they do with only a short period of observation in one particular locality, but urges that they are definite enough to warrant the obtaining of a longer record at a place, situated within or near the tropics, where earthquakes are of frequent occurrence.

MISHONGNOVI ANTELOPE-SNAKE CEREMONIES.[1]

IN each of five of the seven Hopi pueblos of Arizona are performed during each year from eight to twelve ceremonies of nine days' duration. The rites of the first eight days are secret, and have certain elements in common; all terminate on the ninth day in a public performance, which has many elements of a gorgeous pageant.

Of the summer ceremonies, those held by the Antelope and Snake societies, which cooperate, are the most spectacular and best known. They alternate in each village annually, with the ceremonies performed by the Drab- and Blue-Flute societies. Thus, in even years, the Snake and Antelope societies perform in Oraibi, Shumopovi and Shipaulovi, and all Flute societies in Mishongnovi and Oraibi; in odd years, the reverse is true.

The time of the Snake-Antelope ceremonies is determined by the date of the last day of the Niman ceremony, which occurs in July, and at which time the Katcinas and masked gods disappear until the following winter.

Four days from this time, certain priests of the Snake-Antelope societies meet in a room, make certain *bahos* or prayer sticks, which are deposited in a shrine on the following morning, at which time the village Crier announces from the house-top the date of the first day of the Snake-Antelope performance, four days hence.

At that time, the chief priests of the Snake-Antelope fraternities meet in their respective *kivas* or underground chambers. During the next four days, the Antelope priests gather in constantly increasing numbers in their *kivas*, make *bahos*, indulge in fraternal smoking, and on the fifth day, prepare on the floor of their *kiva* a sand picture and erect their altar.

During this time the Snake priests have been engaged in a ceremonial hunt for snakes, scouring the country to the north on the first day, on the west on the second, &c.

Very early on the sixth, seventh, eighth and ninth days the Antelope priests gather about their altar, and, reinforced by the chief priest of the Snake society and two personages representing the Snake Youth and Antelope Maiden of the legend, sing eight traditional songs. These performances are the most beautiful and sacred of the entire ceremony. On the eighth and ninth days of this singing ceremony there is the added element of two Snake men, dressed as Kalehtaka or Warriors, who perform with the bull-roarer and lightning-shooter, after which they, with an Antelope priest and fifty or sixty young men of the village, repair to a spot in a plain far below the mesa, where, after the deposition of *bahos* and the laying of cloud symbols by the Antelope priest, there begins a spirited and exciting race on the part of the young men to the summit of the mesa. The winner of the race on each morning receives from the hands of the chief of the Antelope priests a small netted gourd containing water from the medicine bowl, which has been fertilised by smoke, which he later deposits in his field.

On the afternoon of the eighth day occurs a public performance in the plaza, participated in by all the Antelope and Snake priests, properly costumed, at which time the Antelope men in turn carry in their mouths a corn-husk packet, receiving it from the *kisi* or booth of cottonwood especially erected in the plaza for this purpose.

On the ninth day occurs the most sacredly guarded event in the Snake *kiva*. At noon the snakes, numbering from sixty to eighty, one-third or one-fourth being rattlesnakes, which have been guarded in this *kiva* in earthenware jars, are placed in one large bag. The Snake priests gather along one side of the *kiva* in line, seated upon stones. In front of the chief priest is a bowl containing medicine water.

1 "The Mishongnovi Ceremonies of the Snake and Antelope Fraternities." By George A. Dorsey and H. R. Voth. Field Columbian Museum Publication 66, Anthropological Series, vol. iii. No. 3.

The Snake priests begin shaking their snake whips, beating time to the set of traditional songs which they now sing; the chief priest now plunges his hands into the sack and grabs as many snakes as possible, and thrusts them into the medicine bowl in front of him, then violently casts them upon the floor of the *kiva* immediately in front of the priests, the floor having been covered with a two-inch layer of sand. This continues until all the snakes have been washed, the priests herding the snakes with their whips, hands and bare feet.

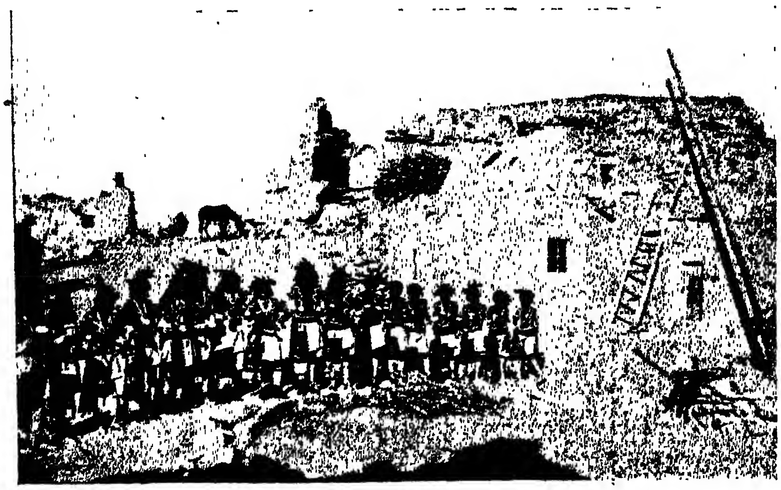


FIG. 1.—Antelope Priests leaving the Kiva.

The remainder of the afternoon is spent by the priests of both fraternities in properly costuming themselves for the final and public performance, which begins as the sun is about to sink behind the San Francisco Mountains in the west.

In the meantime three or four naked boys have been herding the snakes in a corner of the *kiva* and playing with them, tossing them, one to another, with a reckless abandon which at first is startling and finally commonplace.

The hour having arrived for the dance, the snakes are again gathered up, thrust into a sack, and carried by one of the priests to the *kisi* in the plaza, within which he secretes himself. The Antelope priests are first to leave their *kiva*, and proceed in single file, led by their chief priest, to the plaza, which they circle four times and halt in line in front of the *kisi*. They are closely followed by the Snake priests, who perform similar evolutions, halting also in front of the *kisi*, but facing the Antelope priests. The appearance of the men at this time, as they proceed to the plaza, is very striking and beautiful, forming a sight not to be forgotten. In this attitude they sing several songs, the time to which is kept by the snake men with their snake whips and long black *bahos*, and by the antelope men with their peculiar Antelope rattles. As the singing proceeds the positions of the bodies of the men are changed from time to time, in accordance, presumably, with the movement of the drama. As the end of a certain song is reached the man at the head of the line of the Snake priests leaves his position, passes down to the centre of the line of the Antelope priests and in front of the *kisi*, where he stops, passes his hand in between the Antelope priests, and receives from the priest within the *kisi* a snake, which he grasps with his lips, at a position about four inches from the snake's head. He is called the "carrier." He is followed by a second Snake priest called the "hugger," who passes his arm over the first priest's shoulder and, with his snake whip, guards the "carrier's" face from the snake's head. The "hugger," in turn, is followed by the third Snake priest, known as the "gatherer," whose duty it is to pick up the snake should it wriggle from the "carrier's" mouth; and so the entire line of Snake priests files by the *kisi*, every third man receiving a live snake, which he places in his mouth. Thus they proceed in an elongated circuit, each "carrier" dropping his snake as he again approaches the *kisi*, where he receives a fresh snake. By the time all the snakes have been passed out, the hands of the "carriers" are well filled with the wriggling snakes.

A circle of white meal is now spread upon the ground in front of the Antelope priests, into which the "carriers" cast the snakes in one heap. The Snake priests now run by the snakes, and each man plunges both hands into the mass, and, grasping as many as he can, starts off down the mesa-side, the first man to the north, the second to the west, and so on, until all the snakes have been removed, each priest depositing his snakes together with a *baho* half-way down the side of the mesa.

The antelope priests, in the meantime, have again circled the plaza four times, and have returned to the roof of the Snake *kiva*, where they and the now returning Snake priests drink freely from the great bowls of emetic which produces violent vomiting. The priests now repair to their respective *kivas*, where they disrobe. In the Snake *kiva* there is an additional discharming ceremony, followed by a feast, this being the first food the chief priests have taken for four days, and the other priests since the preceding day.

FIG. 2.—Line of Snake Priests leaving the Kiva.

The four days following this public performance are devoted largely to sports and games of children, in which struggles for prizes of corn, melons, &c., together with rabbit hunts, play an important part.

The performances just described in outline only dramatise the legend of the Snake clan. The entire movement of the ceremony has for its immediate and ultimate object the

preparation of a medicine or magic which will be so efficacious as to overcome the magic of the rain clouds, and cause them to give up their stores of water; for the August suns in the south-west are rapidly drying up the corn, which, without rain at this period of the year, would be a failure. But when it is remembered that the Hopi live almost entirely upon vegetable products, of which corn forms almost 80 per cent., it will readily be understood that, should the combined efforts of the two sets of priests be not successful, famine must be the result. As each snake is released with a *baho*, it bears with it prayers which it is supposed to transmit to the great plumed serpent, who has influence with the rain gods of the four world quarters. It may be added that the fundamental element of nearly all Hopi ceremonies is the production of a magic which will overcome the magic of the rain clouds.

So far as the writer is aware, no Hopi has ever died as a result of a snake-bite during these ceremonies. Nor has he ever seen a priest bitten by a snake. He is positive that nothing is done to render the snakes harmless. Nor do the Hopi have any antidote for the poison of the rattle-snake. The Hopi seems thoroughly to understand the rattle-snake, and is cautious never to attempt to pick him up when in a coiled position. The Snake priest always carries with him his snake whip, which he shakes over the snake when coiled, as he is about to pick it up in the fields during the hunt, or in the *kiva* as he transfers it from the snake bag to the receptacle, or as he herds the snakes in the *kiva*, or picks them up on the plaza. Rarely is a snake seen coiled, its ambition being to escape.

GEORGE A. DORSEY.

b

FIG. 3.—Priest using the Snake Whip preparatory to picking up a Snake.

WERE THE FERN-CYCADS SEED-BEARING PLANTS?

THIS was the burden of a preliminary paper read at the Royal Society on May 7 by Prof. F. W. Oliver and Dr. D. H. Scott, F.R.S., entitled "*Lagenostoma Lomaxi*, the seed of Lyginodendron."

During recent years the petrified remains of many fern-like plants from the Carboniferous rocks have received close attention, with the striking result that the internal organisation of not a few shows a marked approach to that characteristic of the Cycads, the most primitive of existing seed plants. These plants, therefore, whilst retaining the outward form of ferns, are in reality transitional types. For convenience, these plants, which include the genera Heterangium, Lyginodendron, Medullosa, and many others, have been placed in a special group, the Cycadofilices or Fern-Cycads. The recognition of this group is one of the more interesting results that has accrued in recent years in fossil botany, and the view that the Cycadofilices are the remains of a natural bridge connecting the ferns and the Gymnosperms has received wide support.

In no case, however, had the fructification of any Fern-Cycad been definitely recognised, hence it remained an open question whether the Cycadean advance which was so marked a feature of the vegetative organs found its counterpart in the reproductive process.

In the paper under notice the authors bring forward what they regard as adequate evidence for assigning a seed to Lyginodendron, perhaps the best known of all Cycadofilices, owing to its admirable preservation and very common occurrence in the calcareous nodules of the Lower Coal-measures.

Numerous detached seeds are known from the Palæozoic rocks, but in no case has it been ascertained by what plants these seeds were borne, with the exception of certain forms which have been traced to the extinct family of the Cordaiteæ, and the curious seed-like fructifications of two Lycopods, Lepidocarpon and Miadesmia. The rest, although of great interest in the details of their organisation, have remained unassigned, being without traces of their origin, like fallen acorns in a forest.

In the case, however, of the seeds placed by Williamson in his genus Lagenostoma, a re-examination has revealed unexpected points of agreement between the structure of the envelopes of certain of these seeds, on the one hand, and the vegetative organs of Lyginodendron on the other. It appears that the seed named *Lagenostoma Lomaxi* after its discoverer, and occurring chiefly at Dulesgate, in Lancashire, is sometimes still attached to its pedicel, and is found enclosed in an envelope or cupule springing from the stalk just below the base of the seed, and extending above the micropyle, at least in young specimens. The cupule, in its relation to the seed, which is quite small,

not larger than a pea, may be compared to the husk of a hazel-nut in miniature.

Both cupule and stalk bear numerous capitate glands, some stalked, others sessile, which present the closest agreement in size, form and structure with the glands which occur on the vegetative organs of Lyginodendron. It is the agreement between these glands, so close as to amount to identity, that forms the basis of the attribution of the seed to Lyginodendron. There is no other known plant from the Coal-measures with glands at all similar, nor is it likely that any unknown Gymnosperm should exactly resemble Lyginodendron in these characters. The vascular strands which traverse stalk and cupule present the closest agreement with those of Lyginodendron, and these and other characters go to strengthen the conclusion drawn from a comparison of the glands, and further support the attribution. The evidence will, of course, be weighed by botanists. Should it find acceptation, we have the following position. Lyginodendron, a fern-like plant with certain Cycadean characters, possessed seeds (on its leaves, so it may be inferred from the structure of the stalk and cupule) as fully characterised as those of any known Palæozoic gymnosperm. It retains, so far as its vegetative structure is concerned, the intermediate position already assigned to it, but whereas the fern-like characters have hitherto seemed to preponderate, the discovery of the seed inclines the balance strongly on the Gymnospermous side. The germ of the present discovery dates from the time when it became apparent on anatomical grounds that Lyginodendron was a transitional type. Dr. Scott in his published writings had already prepared the way, and the position now gained is the logical sequel. Nor is it likely that Lyginodendron stood alone; we must be prepared to find, what has long been recognised as a possibility, that many of the plants grouped under Cycadofilices already possessed seeds, and thus that a considerable proportion of the so-called "fern-fronds" of the Palæobotanist really belonged to seed-bearing plants. The status of these "ferns" may be expected to take many years to unravel, owing to the difficulties that will be encountered in discriminating between such as bear true fern-sporangia and those the sporangia of which are really the pollen-sacs of Gymnospermous plants, and in allocating the numerous impressions which are quite sterile. It is premature to speculate how far back in the fern-series a seed habit obtained, but the results of further investigations in this field will be awaited with interest.

"TABLOID" PREPARATIONS FOR PHOTOGRAPHY.

THERE is probably no one who has reason occasionally to take a photograph, whether for simple pleasure or for scientific or business purposes, without having at command a well-equipped photographic laboratory, who does not consider the preparation of the various solutions required as a messy, troublesome and tedious performance. And the getting of some of the chemical substances in a fit state for use is a very real difficulty, only to be got over in some cases by procuring the original packages or bottles as issued by the manufacturer, and containing perhaps twenty times as much as is required. We have known several cases where so common a substance as sodium sulphite has been obtained only after seeking for it at several druggists, and other cases where the work was spoilt by reason of the gross impurity of the material.

These and similar difficulties are now matters of the past for those who use the "tabloid" preparations of Messrs. Burroughs, Wellcome and Co. Instead of a large bottle of stuff awkward to manipulate because either the substance is in hard lumps or light feathery crystals, one has a little bottle of little pills that need no weighing, because the contents of each are indicated on the label. In the majority of cases each tabloid has in it the quantity of material needed for one ounce of solution, so that any bulk can be made up without the possibility of error in calculation. The tabloids required are put into the measure glass, water added, stirred a little or crushed with a glass rod, and the solution is ready for use, with the advantage that it is fresh, and made with materials that can be relied on.

In many cases the requisite chemicals are mixed in the one tabloid, sulphite, alkali, and bromide, for example in developers, but there are no secret formulæ, as the contents of every tabloid are clearly set forth on the label. The formula, if necessary, can be modified to any extent by adding to it a tabloid of one or the other ingredients; or, if preferred, tabloids of simple unmixed substances may be used throughout.

So far as variety goes, practically everything that is required in photographic practice is supplied, including even such rarely used chemicals as potassium percarbonate and ammonium persulphate. There is a large selection for making gold baths for the toning of prints, and potassium ammonium chromate is supplied in 24-grain tabloids for sensitising carbon tissue. Ferrous oxalate and mercuric chloride are the only two omissions that we note; perhaps there is some difficulty with regard to these.

It appeared not unlikely that some of the chemicals might show signs of deterioration from their manipulation in the preparation of the tabloids, but those that we have tested have proved unexceptionable in quality. These preparations are worthy the attention of even the best equipped photographer working at home in his own laboratory, particularly with regard to the chemicals that are rarely required.

A NEW INDEX OF APPLIED SCIENCE.

WE have received a copy of the first issue of a new monthly periodical[1] published at Brussels. The title, *Index of the Technical Press,* appears on it in the three languages French, English and German. The object of the publication is to supply a monthly index of articles of general interest appearing in the technical Press throughout the world, and giving the title with a brief explanation, the name of the author, the origin, the date of publication, and the length. In the case of articles appearing in the English, French, and German papers, these details are given in the languages in which they originally appeared. In the case of articles printed in other languages they are translated into French.

One very good characteristic of the publication is that it is printed on one side of the paper only, and in a convenient form for cutting out and pasting on cards for use in connection with card indices.

The publishers undertake to supply cuttings from the original papers of most of the articles indexed, at prices indicated by a letter affixed to each entry. Translations can also be obtained on a fixed scale. Such a publication should be of considerable value if the scheme is carried out with completeness, and the subscription price of five francs per annum is not a heavy one. Much, however, will depend on the interpretation given to the expression "general interest."

The greater part of the issue is taken up with entries of engineering articles under various headings; some of these cover rather a wide field—electrical engineering, for example, forms one of the sections, without any subdivisions.

Besides engineering articles, there are sections devoted to statistics, political science, political economy, law, legislation and jurisprudence, administration, constabulary, insurance and partnership, commerce, communication and transport, mathematics, astronomy, physics, chemistry, geology, medicine. Various trades and manufactures are also included.

The "brief explanation" promised is confined to very slight extensions of the title in some cases, so that the only guide to the value of an article is the name of the author and that of the paper from which it is taken. This, however, if the indexing is really comprehensive, should be of considerable value, more especially with regard to subjects in which systematic abstracts are not obtainable.

Rather numerous errors are made in printing the English and German entries, especially in the former. They are not of a character to cause any inconvenience to those familiar with the languages, but they are unsightly, and their occurrence might easily be obviated by the employment of a proof reader familiar with the languages.

G. W. DE T.

[1] *Index of the Technical Press.* (20 Rue de la Chancellerie, Brussels.)

TRIASSIC CEPHALOPODS.

ALL who are interested in the invertebrata of the Trias will be pleased to see the supplement recently issued to "Die Cephalopoden der Hallstätter Kalke," by Dr. Edmund Mojsisovics (*Abhandlungen der k.k. Geologischen Reichsanstalt*, Band vi., 1902). The first volume of this detailed and beautifully illustrated memoir, published in 1873 and 1875, contained 174 pages of text and 70 finely executed lithographic plates. The second volume appeared in 1893, and extended to 835 pages and 130 plates. The part now published is a supplement to the first volume, and continues the paging from 175 to 356, while the plates are numbered from 1 to 23 as supplementary. It is somewhat difficult for geologists familiar only with the English Trias to realise the richness of the fauna described in this memoir, which, for the sufficient illustration of the Cephalopoda alone, needs 223 large quarto plates. The author speaks in the preface of the somewhat primitive nomenclature of the earlier parts of the first volume, but the most forward student will have nothing to complain of in this direction in the present supplement, unless it be the use of such impossible names as Pompeckjites. Some interesting remarks are made on the subdivisions now adopted for the "Hallstätter Kalke," and a table of these is given on p. 345. Among the forms of Cephalopods here described, none perhaps are more remarkable than the primitive types included in the Belemnitidæ. In transitional deposits such as the Trias one expects to find the lingering of antique forms and the foreshadowing of types yet to come; but it is a little startling to find the Carboniferous genus Pleuronautilus so nearly associated with such forms as Rhacophyllites, which so strongly reminds us of the Liassic *Phylloceras heterophyllus*. The author is to be congratulated on the successful completion of this monumental work, which has engaged his attention for so many years, and, by this supplement, is brought fully abreast of the present time.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Romanes lecture will be delivered by Sir Oliver J. Lodge, F.R.S., in the Sheldonian Theatre on Friday, June 12, at 5 p.m. The subject of the lecture is "Modern Views on Matter."

On Saturday last Prof. Tylor, F.R.S., was elected an honorary fellow of Balliol College, of which he has been a member since his appointment as Keeper of the University Museum and reader in anthropology in 1883.

Last week's *Gazette* contained the report of the museum delegates for 1902. Considerable additions have been made, particularly to the Pitt Rivers and Hope collections. An important change in administration took place after Prof. Tylor resigned the keepership, this office being abolished and replaced by a secretary to the museum delegates. Prof. Miers, F.R.S., was appointed to the new position. During the past year three new laboratories have been added to the chemical department, and an electric installation has been put into the museum

The Junior Scientific Club held a conversazione in the museum on the evening of Tuesday, May 26. Lectures were given by Sir David Salomons, Bart., on "Motor Cars," by Prof. Arthur Thomson on "Man's Cranial Form," and by Prof. Miers on "Klondyke." Among the exhibits were an excellent demonstration of the properties of radium by Mr. F. Soddy, a show of collotype and three-colour printing from the Clarendon Press, an improved form of capillary electrometer by Mr. H. S. Souttar, photographs of the new star in Gemini by Prof. Turner, a collection of living British fresh-water fish by Mr. Morison, a demonstration of the principles of wireless telegraphy by Mr. Littlehailes and Mr. Lattey, and a collection of apparatus from the Cambridge Scientific Instrument Company and the Magdalen College Laboratory.

CAMBRIDGE.—Dr. Chase, president of Queens' College, has been re-elected Vice-Chancellor for the ensuing academical year.

Mr. F. W. W. Griffin, King's, has been appointed to the university table in the Plymouth Marine Biological Laboratory.

In the mathematical tripos, part i., sixty-five men and eighteen women have acquitted themselves so as to deserve mathematical honours.

The memoirs of Mr. J. Parkinson, advanced student of St. John's College, on the geology of Tintagel and Davidstow, and on the rocks of Guernsey, have been adjudged to be "of distinction as a record of original research."

DR. THOMAS SLATER PRICE has been nominated to succeed Mr. Woodward as director of chemical studies at the Birmingham Municipal Technical School.

AN exhibition of practical work executed by candidates at the technological and manual training examinations of the City and Guilds Institute will be opened at the Imperial Institute on Thursday, June 11, at 3 p.m., by the Marquess of Londonderry, K.G.

Science announces that Prof. William H. Brewer has resigned the professorship of agriculture at Yale University and has been appointed professor emeritus. At Cornell University Prof, T. F. Hunt, dean of the Agricultural College, of the Ohio State University, has been appointed professor of agronomy, and Dr. B. F. Kingsbury has been appointed assistant professor of embryology.

ON the occasion of the commemoration day proceedings at Livingstone College, Leyton, on June 10, the Bishop of St. Albans will preside. Livingstone College has rendered valuable services, not only to missionaries, but also to many travellers in unhealthy regions, and it is hoped that the present opportunity will lead to much greater interest being taken in the work carried on under its auspices.

IT is worthy of note that in connection with a short course of popular lectures on nature-study just given by Mr. C. Carus-Wilson at Ramsgate and Margate, excursions were arranged to places of geological interest in the neighbourhood. Field-work and personal observation of natural objects and phenomena are essential in the study of nature, and it is to be hoped that wherever popular lectures are given on natural science subjects, outdoor work will be arranged in connection with them.

THE draft charters incorporating universities in Manchester and Liverpool have, the *Times* reports, been approved by the Privy Council and laid before Parliament. In the case of Manchester, the charter provides that the University shall be called "the Victoria University of Manchester." A description is given of the powers conferred upon the University relating to such matters as the granting and conferring of degrees, the granting of diplomas, the provision of instruction in such branches of learning as the University may think fit, the examination and inspection of schools, and the affiliation of other institutions. The authorities of the University will be the Chancellor, the Vice-Chancellor, two Pro-Vice-Chancellors, the Court, the Council, the Senate, the Board of Faculties, and the Convocation, besides a treasurer and other proper officers. In the case of Liverpool, the charter provides that the University shall be known as "the University of Liverpool." It is provided that Lord Derby shall be the first Chancellor of the University, and Mr. A. W. W. Dale, now principal of University College, Liverpool, the first Vice-Chancellor. The supreme governing body of the University is to be the Court, and the governing body and executive of the University is to be the council; and the Senate, consisting of the Vice-Chancellor, the deans of all the faculties, all the professors of the University, and the librarian, will, subject to the statutes of the University and the control and approval of the council, regulate and superintend the education and discipline of the University.

IT is announced in the *Times* of May 28 that the council of the Yorkshire College has agreed upon the principles upon which the charter for the proposed new Yorkshire University should be based. These are that the Yorkshire College be merged in the University; that the University be founded on a non-federal basis, but that it be empowered to affiliate other institutions; and that the University be governed by a court of governors and by an executive

council. Substantial agreement has been arrived at between the three colleges, which have constituted Victoria University, as to a common matriculation examination for all the three Universities of Yorkshire, Manchester, and Liverpool, and provision has been made for a joint board to be constituted from the three Universities to deal with the question. The additions to the staff and equipment of the college essential to the proper carrying on of an independent University will, it is thought, require a *minimum* additional expenditure of about 7000*l*. a year, while extensive additions will also be required to the college buildings. The coal-owners of Yorkshire have decided to erect a separate building for the mining department, and have collected a sum of 5500*l*. for the purpose. The council of the college is desirous also of completing the main block of the college, and it is estimated that this would cost about 60,000*l*. Three friends of the college have each promised 5000*l*., while a fourth has promised 2000*l*. The Clothworkers' Company of London offers to transfer to the new University as its absolute property the whole of the buildings and equipment of the textile industries, dyeing and art departments, which are at present held in trust by the college for the Clothworkers' Company. Attached to the offer is a condition that these departments shall be recognised as integral parts of the University. The Company has also promised to grant in perpetuity to the University for the maintenance of these departments an annual sum of not less than 4000*l*. This means a gift to the University of a capitalised sum of upwards of 200,000*l*.

WE learn from the *Pioneer Mail* that the Government of India has addressed to the Bombay Government a long letter on the subject of the proposed Tata endowment of a research institute for India. It is in the main an explanation of the delay of four years which has occurred in giving effect to the scheme. As has been already explained in these columns, the scheme owes its origin to the munificent intentions of Mr. J. N. Tata, who in 1896 proposed to vest in trustees properties in Bombay, representing a capital of thirty lakhs of rupees, in order that the net income, amounting to some 8000*l*., might be applied towards the endowment of a research institute for India. The proposal soon assumed the form of an Imperial teaching university, intended to train Indian graduates in scientific research, to confer degrees, and to select the best students for further training in Europe and America. Mr. Tata was later asked to consider whether the original scheme was not too ambitious, and whether it might not be proceeded with, so far as funds permitted, leaving the further development to come with the growth of income. Mr. Tata met a small conference of educational experts, and with them defined the general principles to be kept in view in launching the scheme. Sir William Ramsay was invited to visit India to advise, and the help of other experts was obtained. Much delay has been caused by a consideration of numerous recommendations received, but we are glad to know that financial difficulties appear to have been overcome, and that legislation will probably soon follow with a view to provide India with an institution for higher scientific instruction. The institute is to be located at Bangalore, and the Mysore durbar, in addition to making a free grant of land, has undertaken to contribute 3333*l*. per annum for a period of ten years. The Government of India is prepared to make a similar annual subsidy. This will raise the income to 15,000*l*. per annum, which exceeds by 1000*l*. the highest estimate of necessary expenditure framed by Sir William Ramsay. The Government also proposes to contribute one lakh of rupees towards the cost of the construction and equipment of the necessary buildings. The institute is to comprise a department of chemistry, a department of experimental physics, and a department of experimental biology.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 14.—"The Combination of Hydrogen and Chlorine under the Influence of Light." By P. V. **Bevan.** Communicated by Prof. J. J. Thomson, F.R.S.

The first point studied in this investigation was the initial expansion, or Draper effect, when light is allowed to fall on a mixture of hydrogen and chlorine. This expansion was shown to be due to heat developed by the combination of the hydrogen and chlorine to form hydrochloric acid. The heat effect was measured by the change in resistance observed in a fine platinum wire sealed through the bulb in which the gas mixture was exposed to light. The investigation then considers the period of induction of Bunsen and Roscoe, and the effects of various intensities of light on the rate of combination. Experiments were also made on the effect of illuminating chlorine before mixing with hydrogen, and the original observation of Draper—that the combination takes place more readily after this preillumination—was confirmed. If, however, the gases be bubbled through water after preillumination of chlorine, this effect is destroyed, and the gases behave like the ordinary mixture. To obtain evidence of an intermediate compound, the gases were submitted to sudden expansion producing supersaturation. When the gases were dust free a nucleus-forming substance occurred after illumination, so that on the expansion a cloud was formed when the supersaturation reached a certain amount. In the non-illuminated gas mixture no cloud-producing substance could be observed with yellow light. This cloud is produced in chlorine alone. In the mixture of hydrogen and chlorine the cloud appears before any hydrochloric acid is formed. The theoretical part of the paper considers the action as taking place in three stages, combination to form complex molecules containing hydrogen chlorine and water molecules occurring, and then a break down of this complex system giving hydrochloric acid and water. The view thus taken explains the chief features of the induction period, and can be extended to apply to other similar actions where a catalyser is necessary for the progress of the action.

"On the Photo-electric Discharge from Metallic Surfaces in Different Gases." By W. Mansergh **Varley,** M.Sc., Ph.D. Communicated by Prof. J. J. Thomson, F.R.S.

The object of the experiments was to study the effect of the pressure and nature of the gas with which a metal surface is surrounded upon the magnitude of the photo-electric current from that surface, the method used being to draw the complete curves connecting the current and the potential difference at each pressure or in each gas examined, keeping the intensity of the ultra-violet illumination and the other conditions unaltered.

A suitable source of ultra-violet light which would remain constant in intensity while long series of observations were being taken was ultimately found in the spark between iron terminals in an atmosphere of pure dry hydrogen. The spark gap was in parallel with three Leyden jars in the secondary circuit of an induction coil used as a transformer. The photo-electric currents were measured from a metal surface placed a few millimetres behind a fine gauze, through which the light passed, and which served as the positive electrode. A brass vessel, with a quartz window, to admit the light, served to contain the electrodes.

Series of curves were obtained showing the relation between the photo-electric current and the potential at pressures ranging from 760 mm. to 0·0014 mm. They show that down to pressures of about 1 mm. no true saturation currents exist, the currents always increasing with the potential, but less rapidly for a certain range of potential gradients than for lower or higher potential gradients, while at pressures below the critical pressure true saturation currents exist.

Curves connecting the potentials and corresponding photo-electric currents in air, carbon dioxide, hydrogen and carbon monoxide at various pressures were also obtained, and it was shown that the curves could all be explained on the ionic theory of conduction, both qualitatively and quantitatively. Zinc, platinum and aluminium electrodes were employed.

"On the Discovery of a Species of Trypanosoma in the Cerebro-spinal Fluid of Cases of Sleeping Sickness." By Aldo **Castellani,** M.D. Communicated by the Malaria Committee of the Royal Society.

The author states that he has found trypanosomes to be present in the cerebro-spinal fluid in twenty out of thirty-four cases of sleeping sickness examined; in two of the cases trypanosomes were also found in the lateral ventricles, and in one in the blood taken from the finger. The cerebro-spinal fluid was obtained by lumbar puncture, and as the trypanosomes are not numerous, it was first centri-

fugalised and the deposit examined microscopically. This species of trypanosoma seems to differ from that found in human trypanosomiasis (*T. Gambiense*, Dutton) by being less motile, by the micro-nucleus being situated nearer the extremity, and by the vacuole being larger. Should it prove to be a new species, the author suggests that it should be named the *Trypanosoma Ugandense*. The author had previously isolated a streptococcus in this disease; he now suggests as a working hypothesis that sleeping sickness is due to a trypanosoma, and that in the last stages there is a concomitant streptococci infection.

In a note to this communication the secretary of the Royal Society (Sir M. Foster) states that a telegram has been received from Colonel Bruce, who is continuing Dr. Castellani's investigations in Uganda, announcing that he has found trypanosomes in the cerebro-spinal fluid in every one of thirty-eight cases examined, and in the blood in twelve out of thirteen cases.

Physical Society, May 22.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—Mr. J. **Stöttner** gave an exhibition of Nernst lamps, showing their development from the experimental form up to the most recent types. The oxides used for the glowers are thoria, zirconia, and other rare earths thereto related, such as oxides of yttrium and cerium. A paste of these is formed, and small rods or tubes are pressed through a suitable nozzle. These are hardened and cut into small lengths, and practically the principal part of the lamp is finished. The chief difficulty in the practical lamp is in the design of a durable automatic heater to heat the filament up to conducting point. A number of automatic arrangements which have been designed for disconnecting the heater were shown. Another important part of a Nernst lamp is the bolstering resistance, which in its final development consists of a thin iron wire sealed in a glass bulb filled with hydrogen gas. If a lamp is used without a bolstering resistance, as soon as a certain critical potential is reached the current increases, at first slowly and then quicker and quicker, the potential remaining constant, until the lamp burns itself out.—Mr. T. H. **Blakesley** gave an exhibition of a diagram for single-piece lenses. The properties of a single-piece lens are determined by four factors:—the two radii of curvature, the thickness of the lens, and the value of the refractive index of the material of which it is composed. In the case of a lens of a particular thickness made of a material of definite refractive index, the variables reduce to two, namely, the ratios of the radii of curvature to the thickness of the lens. Any property of the lens requires a relation between these quantities. It is therefore possible, for any property, to draw a curve, with r_1/d as ordinates and r_2/d as abscissæ, such that any point on the curve represents a lens having that property. Mr. Blakesley has drawn curves representing several properties. Where two curves cut there is a point which gives a lens having the properties due to both curves. By means of such a diagram various lenses have been constructed, and three of them were shown at the meeting. Of these, one was equivalent to a Huyghens eye-piece and another to a collimator.—A paper on an instrument for measuring the lateral contraction of tie-bars, and on the determination of Poisson's ratio, was read by Mr. J. **Morrow**. Practical methods for the determination of the ratio of lateral to linear strain in a tie-bar may be divided into three classes. First, those in which two coefficients of elasticity are determined and Poisson's ratio calculated; second, those depending on the deformation of the section of a beam; and lastly, methods by which the two strains are actually measured. The experiments described in the paper belong to the third. From a table of results, it appears that the average values of σ are for mild steel 0·275, Sheffield spindle steel 0·276, wrought iron 0·277, Muntz metal 0·341, and drawn copper 0·327. The specimens were not annealed, and were mostly about one inch in diameter. For the experiments on cast iron, two series of specimens were carefully cast of material of good average quality. These were loaded several times in order to eliminate permanent set. The first series gave an average value $\sigma = 0·246$ and the second $\sigma = 0·252$.

Chemical Society, May 20.—Prof. W. A. Tilden, F.R.S., president, in the chair.—The following papers were read:—The conditions of decomposition of ammonium nitrite, by V. H. **Veley**. The decomposition of ammonium nitrite into nitrogen and water proceeds according to the general law $\log. A/A-x = a\theta$, whether the reaction follows its normal course or is accelerated by the addition of another substance. The decomposition is either impeded or stopped by ammonia, aliphatic, benzenoid or pyridine amines and aromatic hydrazines, and to a less degree by oximes, but is accelerated by aliphatic amides.—Freezing point curves for some binary mixtures of organic substances, chiefly phenols and amines, by Dr. J. C. **Philip**. When freezing point curves for mixtures of two substances are constructed two types are obtained:—(*a*) a curve consisting of two branches, starting from the freezing points of the constituents and cutting each other at a eutectic point; (*b*) the two branches are cut by a third intermediate curve, which may sometimes have a summit. Examples of the latter type have been found for the systems *phenol—urea*, p-*cresol—aniline*, *phenol—α-naphthylamine*, *phenol*—p-*toluidine*, *α-naphthol*—p-*toluidine*, *phenol—picric acid*.—Isomeric partially racemic salts containing quinquevalent nitrogen. Part xi. Derivatives of *dl*-methylhydrindamine and *dl*-*neo*-methylhydrindamine. Isomeric salts of the type $NR_1R_2H_3$, by G. **Tattersall** and F. S. **Kipping**. A description of these compounds was given.—The action of liquefied ammonia on chromic chloride, by W. R. **Lang** and C. M. **Carson**. In this reaction a salmon-coloured powder is produced from which water extracts two unstable, crystalline compounds with the formulæ $Cr_2Cl_6,12NH_3,2H_2O$ and $Cr_2Cl_6,10NH_3$.—Note on the action of methylamine on chromic chloride, by W. R. **Lang** and E. H. **Jolliffe**. The reaction is similar to the foregoing, the product being a pink substance of the composition $Cr_2Cl_6,10CH_3.NH_2$.—Cholesterol, by R. H. **Pickard** and J. **Yates**. The oxidation and hydrolytic products of cholesterol obtained from gall stones have been studied; among the former is arachidic acid.—Sulphocampholenecarboxylic acid, by Messrs. **Hardy** and **Lapworth**.—Optically active esters of β-ketonic and β-aldehydic acids. iii. Azo-derivatives of menthyl acetoacetate, by A. **Lapworth**.—Hydrogen cyanide in fodder plants, by J. C. **Brünnich**. The observation of Dunstan and Henry that the amount of prussic acid producible from the Sorghum plant increases as the plant matures and decreases after the production of seed has been confirmed by a series of determinations of the prussic acid obtainable from manured and unmanured plants at all stages of growth.—The chemical reactions involved in the rusting of iron, by Prof. W. R. **Dunstan**, F.R.S. It is shown that the presence of liquid water and oxygen is necessary for the formation of iron rust; this action is merely accelerated, not conditioned by the presence of carbon dioxide. No rusting occurs when pure iron is kept in presence of oxygen and water vapour at constant temperature; the rusting of iron is prevented by the presence of solutions of such salts as decompose hydrogen peroxide, whilst its formation is not inhibited in solutions of salts in presence of which hydrogen peroxide is stable. The deduction is therefore drawn that hydrogen peroxide is the active agent in the production of iron rust.

Geological Society, April 29.—Mr. J. J. H. Teall, F.R.S., vice-president, in the chair.—The age of the principal lake-basins between the Jura and the Alps, by Dr. Charles S. Du Riche **Preller**. The author deals with the question reserved from a preceding paper, that is, to which subsequent period the formation of Swiss lake-basins should be assigned. By the light of further recent investigations in the different localities, he first considers the conditions of the Zurich lake-valley, and then applies his conclusions to the other principal lake-basins lying in the same zone along the edge of the Alps. Evidence is adduced to show that the deep-level gravel-beds in the Limmat Valley near and below Zurich are essentially fluviatile, composed of the characteristic Alpine material of the Rhine and Linth drainage-areas, and similar to the gravel now carried by the River Sihl. These gravel-beds rest upon Glacial clay of the second glaciation, which fills the Molasse-bed of the valley to a great depth, and are overlain by the moraine-bars of the third glaciation, the latter being overlain by the post-Glacial alluvia of the Sihl. On mechanical grounds, it is difficult to conceive how glaciers could either bridge or completely fill with ice such extensive basins as those of the principal Alpine lakes. As regards the more recently enunciated

argument of the Deckenschotter and overlying gravel-exposure in the Lorze Valley, apart from the difficulty of differentiating the second and third glaciation materials in that locality, it is hazardous to deduce from a local phenomenon, and more especially from any dip of loose gravel, the date of the zonal bending extending over more than 200 miles along the edge of the Alps. The author suggests that the deep-level Limmat gravel beds were deposited by a river during the second inter-Glacial period; that the lowering of the valley floor was initiated in the course of the third glaciation; that the zonal subsidence continued throughout the retreat of the ice; and that the simultaneous formation of the lake-basin should be assigned to the end of the Glacial period. The same arguments apply also to the origin and age of the other principal zonal lake-basins. In his view, the position and depth of these basins, as well as the intervening ground, point to the probability that the bending took place not only along one line, but along several, that the bending was by no means of uniform depth, and that therefore the Alps did not subside as a rigid mass, but that the zonal bending along their edge merely extended locally for some distance from the deepest points of the lake-basins along the floors of the principal Alpine river valleys.—On a shelly Boulder-clay in the so-called palagonite formation of Iceland, by Helgi **Pjetursson**. There is no equivalent in the Tertiary basalt plateaux of Britain of the great palagonite formation of Iceland. The basement layer of the breccia formation, resting directly upon the basalts, contains glaciated blocks of all sizes. These ground moraines are followed by tufaceous sandstones, conglomerate, columnar basalts, other ground moraines, and volcanic tuffs and breccias. At Birlandshöfdi a shelly Boulder-clay, 70 to 80 feet thick, rests upon the fundamental basalt, which here shows a glaciated surface. Unbroken shells are very rare. *Astarte borealis* is the most common shell, and *Saxicava arctica* and *Mya truncata* are less common, indicating that some of the older moraines are of Pleistocene age. The author concludes that volcanic activity did not pause in Iceland during the Glacial period, but that it was especially active at the beginning and the close of glaciation.

Anthropological Institute, May 5.—Mr. H. **Balfour**, the president, exhibited a stone celt, worn as an amulet, from Benin; some silver *ex voto* offerings from Malabar, and a dagger from Siam, on the sheath of which were natural markings, interpreted by the natives to represent the name of Allah.—Mr. A. L. **Lewis** read a paper on some stone circles in Derbyshire. Mr. Lewis first dealt with the Arborlow circle, which has recently been excavated by Mr. Gray under the auspices of the British Association. Like the Avebury circle, Arborlow is surrounded by an embankment outside a ditch, the latter, therefore, obviously not intended for defensive purposes. All the stones are now flat, with the exception of one which is leaning, and in consequence of this it is extremely difficult to fix the circumferential line or diameter. The general plan, however, is oval. Mr. Lewis was of opinion that in the centre there was a group of three upright stones opening to a point somewhat north of east, and facing probably to the Beltane sunrise. A skeleton—apparently a late interment—was found in the centre, but part of the embankment on the south-east has been formed into a tumulus, which was found to contain an interment of the Bronze age. Mr. Lewis was of opinion that sepulture was no part of the original purpose of the monument. Mr. Lewis also referred to other Derbyshire circles, including the "Wet Withins" and the "Nine Ladies." With regard to the latter, he was of opinion that the term "nine" as applied to standing stones simply meant "holy," and in support of this view he cited several instances of the sacred or mystic significance of the number.—Mr. **Lewis** also read a paper on some notes on orientation. He began by referring to the association—pointed out by Dr. Rivers—between south and right in Welsh and other languages, and considered that the reason was that, when the connection first arose, the people, for some ceremonial purpose, were accustomed to turn to the east on certain occasions, when their right sides would become their south sides, and he incidentally referred to the almost universal practice of church-goers of turning to the east at the recitation of the Creeds. He felt, therefore, that it was possible that the connection went no further back than the origin of this present-day custom, but still it might have originated in far remoter periods. The Greeks looked upon the right side as prosperous, while the Romans looked upon it as unlucky; but this was due to the fact that, while both peoples looked upon the north-east as the favourable quarter, the Greeks in their auguries turned to the north, while the Romans turned to the south. Mr. Lewis mentioned many instances showing how the north was looked upon as unlucky and the south as lucky, but this belief is by no means universal, and on the whole the north-east seems to be considered the most favourable quarter, and then the east. Summarising, Mr. Lewis was of opinion that on the whole the quarter from which the sunlight came was considered most favourable, and that the question of the favourableness of the right or left sides depended on the position taken up at the ceremonies. In conclusion, Mr. Lewis referred to a sort of symbolism of three and one which he had noticed in several stone circles. In a small circle in the Isle of Man there was a combination of one and three stones, but in many instances natural objects—especially the peaks of hills—have been used to suggest the symbolism. This is particularly noticeable at the circle at Penmaenmawr, where the Great Orme and two other hills make a trinity to the north-east, and at the circle on Bodmin Moor, where the three tips of Brown Willy are visible, due east of the circle, over a low intervening ridge.

Entomological Society, May 6.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. Willoughby **Gardner** exhibited nest cells of *Osmia xanthomelana* from Conway, North Wales. He said the species, one of our rarer mason bees, places its beautifully constructed pitcher-shaped cells at the roots of grass, usually four or five together. There is no previous record of the nest having been found since Mr. Waterhouse discovered and described it from Liverpool about sixty-five years ago.—Mr. M. **Jacoby** exhibited *Arsoa longimana*, Fairm., and *A. aranea*, from Madagascar, the only other specimens of these species he knew of being in the British Museum collection. He also exhibited *Megalopus melipona*, Bates, and *M. pilipes* from the Amazon, which bore a remarkable resemblance to a bee.—Mr. A. J. **Chitty** exhibited *Hydroporus bilineatus*, Sturm., a water-beetle new to Britain, discovered by Mr. Edward Waterhouse among some specimens of Hydroporus from Deal, given by Mr. Chitty to him as *H. granularis*. He also exhibited a specimen of the rare *Trechus rivularis* (*incilis* of Dawson), taken at Wicken Fen in August, 1900.—Mr. O. E. **Janson** exhibited specimens of *Neophaedimus melaleucus*, Fairm., a goliath beetle from Upper Tonkin, and remarked that the white colouring was derived from a dense clothing of peculiar semi-transparent coarse scales which were apparently easily removed by abrasion, and seemed to partake of the nature of the "fugitive" scales found upon freshly-emerged specimens of Hemaris and other Lepidoptera.—The president read a communication from Mr. G. F. **Leigh** on protective resemblance and other modes of defence adopted by the larvæ and pupæ of Natal Lepidoptera. He also exhibited the cocoons of *Eublemmistis chlorozonea* to illustrate the paper. Prof. Poulton also showed a specimen of *Polygonia C-album* in the attitude of prolonged repose, together with specimens of *Anaea moeris* set in different ways to illustrate its probable resting position. He said that probably the "C" or "comma" on the under surface of the hind-wings in butterflies belonging to the genus Polygonia (Grapta) represented in bright, strongly-reflecting "body-colour" the light shining through a semi-circular rent in a fragment of dead leaf.—Mr. G. A. J. Rothney communicated descriptions of twelve new genera and species of Ichneumonidæ, and three new species of Ampulex from India, by Peter **Cameron**.

Linnean Society, May 7.—Prof. S. H. Vines, F.R.S., president, in the chair.—The Ingolfiellidæ, fam. n.; a new type of Amphipoda, by Dr. H. J. **Hansen**. The greatest depth explored by the Danish *Ingolf* expedition in the summers of 1895 and 1896 was that of 1870 fathoms, a little south of the entrance to Davis Strait. A small quantity of bottom material showed several forms new to science, amongst which was a single specimen, having a likeness to the Caprellidæ, but with pleopods markedly differing from those of any known Amphipod. Some years later the

author examined a specimen of an allied species obtained by Dr. Th. Mortensen from an island in the Gulf of Siam. These two new species, *Ingolfiella abyssi* and *Ingolfiella littoralis*, one abyssal from the North Atlantic, the other from shallow water in the Pacific, agree in being extremely minute.—On the evolution of the Australian Marsupialia; with remarks on the relationships of the marsupials in general, by Mr. B. Arthur **Bensley**. The paper contains a minute description of the dentition of more than forty genera, and treats also of the structure of the hind foot. Mr. Bensley considers that the primary division of the Marsupialia should be based on the condition (syndactylous or eleutherodactylous) of the second and third digits of the hind foot, rather than on the condition (polyprotodont or diprotodont) of the incisor teeth; and he is disposed on this account to associate the Peramelidæ more closely with the Phalangeridæ than has hitherto been customary. The author regards the Australian marsupials as probably monophyletic, and considers, with Winge, that the ancestral forms were primitive members of the Didelphidæ, a family which must have had a wide geographical distribution in past times. A study of the dentition impels him to the conclusion that the primitive types were all insectivorous, but that the subsequent radiation, or divergent evolution, proceeded along two primary lines, one carnivorous, culminating in Sarcophilus, the other omnivorous and finally herbivorous. In the second line all of the advanced forms are diprotodont, and all of the typical terminal forms are highly specialised herbivora.—Copepoda Calanoida, chiefly abyssal, from the Faroe Channel and other parts of the North Atlantic, by Canon A. M. **Norman**, F.R.S. Most of the Copepoda mentioned were procured by Sir John Murray in the *Triton* expedition of 1882, at various depths to 600 fathoms; a few were from the *Valorous* expedition of 1875; the remainder from a gathering sent by Prof. Haddon from 200 fathoms forty miles N.N.W. of Achill Head. Some of the specimens have been examined and named by Prof. G. O. Sars, and the great interest of the observations now laid before the Society consists in the record of the geographical distribution of these small but ever active crustaceans. Thus, some of the Faroe Channel species found at considerable depths were taken by F. Nansen near the surface at the point reached by him nearest the Pole; the varying depths at which these organisms occur constitute isothermal lines, which largely determine their dispersion.

DUBLIN.

Royal Irish Academy, May 11.—Prof. Atkinson, president, in the chair.—Captain G. E. H. **Barrett-Hamilton** read an abstract of some results of his researches into the meaning of winter whitening in mammals and birds inhabiting snowy countries, and the occurrence of white markings in Vertebrates generally. He finds that the first-named colour-change is not a merely external factor having as its purpose the adaptation of the animal to its environment, but a peripheral atrophy symptomic of deep physiological changes occurring in species possessing a metabolism which varies with the season. Thus the white colour affects the different parts of the body in the same order as that in which subcutaneous fat is accumulated in the panniculus adiposus. The author further finds a connection between much of the permanently white parts of Vertebrates and the accumulation of subcutaneous fat. Such white colour is then due to peripheral atrophy. This atrophy may manifest itself either in deficiency of pigment or in complete absence of hair.—Captain **Barrett-Hamilton** also read a description of a remarkable addition to the list of British mammals of boreal type. This is a bank vole (Evotomys) inhabiting the small island of Skomer, off the coast of Pembrokeshire.—Mr. G. H. **Carpenter** read a paper on the relationships between the classes of the Arthropoda. In opposition to certain recent speculations as to the independent origin of insects, arachnids, and crustaceans from annelid worms, the author advocates a common Arthropod ancestry for the various classes. The conclusion drawn from the numerical agreement in segmentation between typical members of the three great Arthropod classes is that the ancestral arthropods possessed such a definite and limited number of segments, and that those groups with a large number of segments, such as most centipedes and millipedes, and many branchiopoda and trilobites, represent abnormal developments.

PARIS.

Academy of Sciences, May 25.—M. Albert Gaudry in the chair.—The action of acetylene upon cæsium-ammonium and rubidium-ammonium. The preparation and properties of the acetylenic acetylides $C_2.Cs_2,C_2H_2$, $C_2Rb_2.C_2H_2$, and the carbides of cæsium and rubidium, by M. Henri **Moissan**. By the action of acetylene upon solutions of cæsium and rubidium-ammonium compounds of the type C_2R_2,C_2H_2 are formed, from which the carbides C_2R_2 can be obtained by heating *in vacuo*. These carbides react with water, giving the alkali and pure acetylene; they are extremely energetic reducing agents, acting upon the peroxides of lead and manganese with explosive violence.—The influence exerted on the rotatory power of cyclic molecules by the introduction of double linkages into the nuclei containing the asymmetric carbon atom, by M. A. **Haller**. The condensation products obtained by acting upon methylhexanone with aldehydes in presence of sodium methylate have been examined for their rotatory power. The effect of the double linkage is in every case to increase the rotation.—On new sources of radiations capable of traversing metals, wood and other substances, and on the new actions produced by these radiations, by M. R. **Blondlot**. By applying the method described in an earlier paper, using the electric spark as a detector, radiations similar to those detected in the light from an incandescent mantle have now been found to be emitted from an ordinary Argand burner, and from a sheet of incandescent silver. The effects are observed after the radiations have passed through 0·3 mm. of aluminium, black paper, &c., and in the case of the polished silver sheet are polarised, but the polarisation disappears when the silver is covered with lamp black. The name *n*-rays is suggested for these radiations. The *n*-rays are incapable of exciting phosphorescence in bodies which acquire this property under the action of light, but sulphide of calcium, already slightly phosphorescent, shows an increase in lustre when exposed to these rays.—M. Munier-Chalmas was elected a member in the section of mineralogy in the place of the late M. Hautefeuille.—On the development of a given function in series by means of Jacobi polynomials, by M. W. **Stekloff**.—On the integrability of a differential expression, by M. P. **Montel**.—On a theorem of Lejeune-Dirichlet, by M. A. **Pellet**.—On double cylindrical networks, by M. L. **Raffy**.—On the deformation of surfaces, by M. Maurice **Servant**.—The law of displacement of thermodynamic equilibrium, by M. E. **Ariès**.—On the simultaneous variation of solar spots and terrestrial temperatures, by M. Alfred **Angot**. If at any given station the mean annual temperatures, t, present a variation parallel to the number of sun-spots, r, the relation $t=t_0+ar$ will hold approximately, t_0 and a being constants characteristic of the station. This formula is applied to ten years' observations from Guadeloupe.—The thermal conductivity of crystallised bismuth, by M. F. Louis **Perrot**. The conductivity is greatest perpendicular to the axis, and in the direction of the line of easiest cleavage.—On Hertzian waves in wireless telegraphy, by M. G. **Ferrié**.—On the polarised light diffused by refraction, by M. A. **Lafay**.—On the combined hydrogen contained in reduced copper, by M. Anatole **Leduc**. Five litres of air passed over a column of red-hot copper, in such a manner as to ensure superficial oxidation along its whole length, still leaves a weighable amount of hydrogen in the copper.—On the decomposition of lithium carbonate by heat, by M. P. **Lebeau**. Dissociation of lithium carbonate commences at about 600°, the dissociation pressure increasing to 91 mm. at 1000° C., and approaching 300 mm. at 1200° C. An attempt to prepare lithium oxide by heating the carbonate in a vacuum at 1000° was unsuccessful, as the oxide is itself volatile at this temperature, in which respect lithia is sharply differentiated from the alkalies and alkaline earths.—The electrolysis of barium sulphide with a diaphragm, by MM. André **Brochet** and Georges **Ranson**. Polysulphides of barium are formed at the anode, and baryta at the kathode. The latter being placed in a porous pot, the baryta is obtained in a pure state.—On the mode of splitting up of mixed organo-magnesium compounds; the action of ethylene

oxide, by M. V. **Grignard.** The experiments of M. Blaise have been repeated under slightly different conditions, the ether being distilled off before water is added. Good yields of primary alcohols are thus obtained, ethyl magnesium bromide and ethylene oxide giving 62 per cent. of the theoretical yield of normal butyl alcohol.—On acetones containing acetylene linkages. A new synthesis of the pyrazols, by MM. Ch. **Moureu** and M. **Brachin.** Ketones of the type $R—C\equiv C—Co—R^1$, which can be prepared by the action of acid chlorides or anhydrides upon the sodium derivatives of substituted acetylenes, react with hydrazines to form pyrazols. The constitution of pyrazols prepared from unsymmetrical β-diketones can thus be fixed with certainty.—On some addition products of vinyl-acetic acid, by M. R. **Lespieau.**—The electrolytic separation of manganese and iron, of aluminium from iron or nickel, and of zinc from iron, by MM. **Hollard** and **Bertiaux.** The separations are simplified by the reduction of the iron to the ferrous state by means of sulphur dioxide before proceeding to the electrolysis.—On a reaction of methyl violet in presence of sulphurous acid, by M. H. **Causse.** —On the determination of the respiratory exchanges in aquatic media, by MM. J. P. **Bounhiol** and A. **Foix.** —The mandibular glands of the larvæ of the Lepidoptera, by M. L. **Bordas.**—On *Degeeria funebris*, a parasite of *Haltica ampelophaga*, by MM. C. **Vaney** and A. **Conte.**— On the browning of the vine, by MM. L. **Ravaz** and L. **Sicard.**—On the start of a lateral branch inserted on the axis after the division of the embryo, by M. P. **Ledoux.** —On the specialisation of parasitism in *Erysiphe graminis*, by M. Em. **Marchal.**—Sexuality in the genus Monascus, by M. P. A. **Dangeard.**—Contribution to the cytological study of chlorphyllian bodies containing metachromatic corpuscles, by M. Jules **Villard.**—On the presence of cadaverine in the products of the hydrolysis of muscle, by MM. A. **Etard** and A. **Vila.** Cadaverine was isolated in notable quantities from the products of the hydrolysis of muscle in a slightly decomposed state. The occurrence of considerable quantities of this alkaloid in slightly decomposed meat would appear to exclude the hypothesis of microbial formation.—The arrangement of the scales in *Mesosaurus tenuidens*, by M. Léon **Vaillant.**—Retinal inertia relating to the sense of form; its variation according to the criterium adopted. The formation of a wave of sensibility on the retina, by MM. André **Broca** and D. **Sulzer.**—The destruction of termites, by M. A. **Loir.** The ravages of these ants at Bulawayo were so great that special attempts were made to destroy them on the large scale. The use of gaseous sulphur dioxide proved very effectual.—On the artificial culture of the truffle, by M. Raphael **Dubois.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 4.

ROYAL INSTITUTION, at 5.—Electric Resonance and Wireless Telegraphy: Prof. J. A. Fleming, F.R.S.

CHEMICAL SOCIETY, at 8.—Imino-ethers corresponding to Ortho-substituted Benzenoid Amines: G. D. Lander and F. T. Jewson.—(1) Formation of an Anhydride of Camphoryloxime; (2) The Mutarotation of Glucose as influenced by Acids, Bases and Salts; (3) The Solubility of Dynamic Isomerides: T. M. Lowry.—(1) Isomeric Partially Racemic Salts containing Quinquevalent Nitrogen. Part X. The Four Isomeric Hydrindamine d-Chlorocamphorsulphonates $NR_1N_2H_3$; (2) Isomeric Compounds of the Type $NR_1R_2H_3$: F. S. Kipping.—The Hydrolysis of Ethyl Mandelate by the Fat Splitting Enzyme, Lipase: H. D. Dakin.

RÖNTGEN SOCIETY, at 8.30.—On the Electric Field surrounding the X-Ray Tube: Rev. P. Mulholland.

LINNEAN SOCIETY, at 8.—Anatomy and Development of *Comys infelix*, Embleton, a Hymenopterous Parasite of *Lecanium hemisphaericum*: Miss Alice L. Embleton.—Notes on the Transition of Opposite Leaves into the Alternate Arrangement; a New Factor in Morphologic Observation: Percy Groom.

FRIDAY, JUNE 5.

ROYAL INSTITUTION, at 9.—The New Star in Gemini: Prof. H. H. Turner, F.R.S.

PHYSICAL SOCIETY, at 5.—Special Meeting at University College.—Radio-active Processes: Prof. Rutherford.

GEOLOGISTS' ASSOCIATION, at 8.—The Geology of Lower Tweedside, with Special Reference to the Long Excursion: J. G. Goodchild.

SATURDAY, JUNE 6.

ROYAL INSTITUTION, at 3.—The "De Magnete" and its Author: Prof. S. P. Thompson, F.R.S.

MONDAY, JUNE 8.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Journeys in Mongolia: C. W. Campbell.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

WEDNESDAY, JUNE 10.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The First Year's Work of the National Antarctic Expedition: The President.

THURSDAY, JUNE 11.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—*Probable papers*: The Bending of Electric Waves round a Conducting Obstacle; Amended Result: H. M. Macdonald, F.R.S.—On the Propagation of Tremors along the Surface of an Elastic Solid: Prof. H. Lamb, F.R.S.—The Diffusion of Salts in Aqueous Solutions: J. C. Graham.—On the Structure of Gold Leaf, and the Absorption Spectrum of Gold: Prof. J. W. Mallet, F.R.S.—On Reptilian Remains from the Trias of Elgin: G. A. Boulenger, F.R.S.—A Method for the Investigation of Fossils by Serial Sections: Prof. W. J. Sollas, F.R.S.—An Account of the Devonian Fish, *Palaeospondylus Gunni*, Traquair: Prof. W. J. Sollas, F.R.S., and Miss Igerna B. J. Sollas.—The Measurements of Tissue Fluid in Man; Preliminary Note: Dr. G. Oliver.

MATHEMATICAL SOCIETY, at 5.30.—Quaternions: Major P. A. MacMahon.—Automorphic Functions and the General Theory of Algebraic Curves: Mr. H. W. Richmond.—Jacobi's Construction for Quadric Surfaces: Prof. G. B. Mathews.

FRIDAY, JUNE 12.

PHYSICAL SOCIETY, at 5.—Some Experiments on Shadows in an Astigmatic Beam of Light: Prof. S. P. Thompson.—The Positive Ionisation produced by Hot Platinum in Air at Low Pressures: O. W. Richardson.—On a Method of Determining the Viscosity of Pitch-like Solids: Prof. F. T. Trouton and E. S. Andrews.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—A List of Species of Mollusca from South Africa, forming an Appendix to G. B. Sowerby's "Marine Shells of South Africa": E. A. Smith.—On a New Genus, Planorbia, Moore, from the Albert Edward and Albert Nyanzas: J. E. S. Moore.—Notes on Some Jurassic Shells from Borneo, including a New Species of Trigonia: R. Bullen Newton.—Description of *Marginella lateritia*, n.sp., from the Andaman Islands: J. C. Melvill and E. R. Sykes.—New Mollusca from New Zealand: Rev. W. H. Webster.

CONTENTS.

THURSDAY, JUNE 11, 1903.

DIFFERENTIAL EQUATIONS.

A Treatise on Differential Equations. By Prof. A. R. Forsyth, Sc.D., LL.D., Math.D., F.R.S. Pp. xvi + 511. Third Edition. (London: Macmillan and Co., Ltd., 1903.) Price 14*s*.

THE value of this useful text-book has been increased by the inclusion in the third edition of important additional matter.

The principal additions are an account of Runge's method for the approximate numerical solution of ordinary differential equations, of Frobenius's method for the integration of linear equations in series, and of Jacobi's theory of multipliers.

The chief modifications of the matter treated in the earlier editions occur in the treatment of Lagrange's linear partial differential equation of the first order, in the discussion of the condition of integrability of a total differential equation, and in the treatment of Riccati's equation.

Of the above-mentioned subjects the one of greatest theoretic interest is probably the treatment of Lagrange's equation, whilst the most useful is Frobenius's method of integrating linear equations in series.

The theoretic interest of the treatment of Lagrange's equation arises from the fact that until Goursat published his "Leçons sur l'Intégration des Équations aux dérivées partielles du premier ordre" in 1891, the widely used rule for the solution of Lagrange's equation had not received adequate demonstration.[1]

If $u = a$, $v = b$ furnish values of z in terms of x, v which satisfy the equation

$$P\partial z/\partial x + Q\partial z/\partial y = R,$$

where P, Q, R are any functions of x, y, z; and if $\psi(x, y, z) = 0$ be any other integral, then the condition $\frac{\partial[\psi, u, v]}{[x, y, z]} = 0$ must be satisfied, *not necessarily identically, but in virtue of the relation between x, y, z given by $\psi(x, y, z) = 0$.* It is only when the above condition is satisfied identically that ψ is a function of u, v. In this case ψ is certainly included in the general integral. But it is possible to take a case of the general integral, and put it into a form in which the Jacobian does not vanish identically; *e.g.* if $x\partial z/\partial x + y\partial z/\partial y = z$, we may take $u \equiv y/x$, $v \equiv x/z$, $\psi \equiv y/x - x/z$ and the Jacobian vanishes identically; but if we put $\psi \equiv yz - x^2$, then the Jacobian $= -2\psi/(xz^2)$, which vanishes only when the relation between the variables is such as to make $\psi = 0$. Finally, it is possible to have singular integrals, which cannot be expressed in the form of the general integral at all. In this case, let $u = a$, $v = b$ be two integrals, and let $f(x,y,z) = 0$ be any other integral, then by elimination of y, z express $f(x,y,z) = 0$ in the form $\phi(x, u, v) = 0$.[2]

Then if D denote partial differentiation when x, u, v are the independent variables, it can be shown that $PD\phi(x, u, v)/Dx$ must vanish, not identically, but in virtue of the relation between x, y, z given by $f(x, y, z) = 0$. Prof. Forsyth proves that if P, Q, R are regular for values of x, y, z in the vicinity of any point on the integral $f(x, y, z) = 0$, then this integral is included in the general integral. Taking as an example the equation

$$(1 + \sqrt{z - x - y})\, \partial z/\partial x + \partial z/\partial y = 2,$$

we may take

$$u \equiv 2y - z,\ v \equiv y + 2\sqrt{z - x - y};$$

and $z = x + y$ is an integral not included in the general integral. In this case

$$\phi(x, u, v) \equiv (1 - \sqrt{1 + v - u - x})^2,$$

and $PD\phi(x, u, v)/Dx = -\sqrt{z - x - y}$, which vanishes when $z = x + y$. In this case it is at once seen that the coefficient $P \equiv 1 + \sqrt{z - x - y}$ is not regular in the vicinity of points on the integral $z = x + y$.

A similar point, arising out of the conditional vanishing of a Jacobian, comes up in connection with Art. 12. It is there proved that an ordinary differential equation of the first order and degree, with coefficients which are one-valued functions of the variables, has only one independent primitive.

As soon as the reader reaches the subject of singular solutions, he is forced to ask himself why the reasoning in Art. 12 is inapplicable. He wishes to have an explanation of the fact that the many-valuedness of the coefficients causes the reasoning to fail.

Suppose the equation is $2dy/dx + x + \sqrt{x^2 + 4y} = 0$. Two primitives of this are $c^2 + cx - y = 0$ and $x^2 + 4y = 0$. Their Jacobian is $2(x + 2c)$, which does not vanish identically, but conditionally, viz., at the point of contact of the envelope $x^2 + 4y = 0$ by the complete primitive $c^2 + cx - y = 0$.

The method of Frobenius for integrating linear differential equations in series is explained on pp. 235–249, and is applied to the solution of Bessel's equation. It is of a more general character than the special method applied to the same equation in chapter v.; and it exhibits the connection between the two solutions found by it. The connection between the two solutions obtained in chapter v. is difficult to perceive; and Frobenius's method has the advantage both in directness and simplicity. It is a valuable addition to the book.

Runge's method for the numerical solution of differential equations has suffered somewhat in the compression which the author has found necessary. Nevertheless, one cannot help regretting the omission to state the geometrical meaning of the expressions employed, and the connection of the method with Simpson's rule for the approximate evaluation of an integral. The student will probably be greatly perplexed as to the origin of the various quantities introduced and used in the investigation.

There are several difficulties in the discussion of the differential equation which is satisfied by the hypergeometric series in chapter vi. Although the subject cannot be properly dealt with without assuming a knowledge of the theory of functions, which is not to be expected of the majority of the readers of the book, yet there are some very obvious difficulties which could be removed by short explanations.

G

[1] See Chrystal, *Transactions* of the Royal Society of Edinburgh, vol. xxxvi. part ii., p. 551 (1891).

[2] Or by eliminating z, x in the form $\psi(y, u, v) = 0$, or by eliminating x, y in the form $\chi(z, u, v) = 0$.

It is stated (Art. 122) that there is a linear relation between any three of the twenty-four integrals of the equation. The limitation that it is essential to consider only such groups of three integrals as have a common domain does not appear until we reach Art. 124, where it seems to contradict the statement in Art. 122.

The twenty-four integrals are divided into six groups of four each, and the members of each group of four are described as being equal. It should be pointed out that the members of each group of four fall into two pairs, that the members of one of these pairs are equivalent to one another, as they have the same domain; but they do not have the same domain as the members of the other pair (which are equivalent to one another). The four members of a group of four are equivalent to one another only in the domain common to them all. The integrals of one pair are to be regarded as continuations of the integrals of the other pair. From this it follows that in any linear relation between three of the integrals, it is not possible to replace any integral by another member of the group of four to which it belongs without examining whether the integrals appearing in the final relation have a common domain.

For example, relation No. (vi.), p. 219, viz.:—

$$Y_1 = M_5Y_5 + N_5Y_6$$

is intelligible if we take

$$Y_1 = F(\alpha, \beta, \gamma, x)$$

$$Y_5 = (1 - x)^{-\alpha} F\left(\alpha, \gamma - \beta, \alpha - \beta + 1, \frac{1}{1-x}\right)$$

$$Y_6 = (1 - x)^{-\beta} F\left(\beta, \gamma - \alpha, \beta - \alpha + 1, \frac{1}{1-x}\right)$$

because these integrals have a common domain. But it becomes meaningless if we replace

$$Y_5 \text{ by } x^{-\alpha} F\left(\alpha, \alpha - \gamma + 1, \alpha - \beta + 1, \frac{1}{x}\right),$$

which belongs to the same group of four integrals as that previously taken for Y_5; and if we replace

$$Y_6 \text{ by } x^{-\beta} F\left(\beta, \beta - \gamma + 1, \beta - \alpha + 1, \frac{1}{x}\right);$$

for Y_1, Y_5, Y_6 have now no common domain, except possibly points on the unit circle. This peculiarity had been noticed by Kummer in his memoir on the hypergeometric series. He held that even supposing we make the changes described above for Y_5 and Y_6, the equation should not be rejected as meaningless; for the two sides are now the expansions of the same function of x, one proceeding according to powers of x, and convergent inside the unit circle, the other proceeding according to powers of $\frac{1}{x}$ and convergent outside the unit circle; and he illustrated the subject by deducing from one side of one of the equations the expansion of tan x in powers of x, and from the other side of the equation its expansion in powers of $\frac{1}{x}$.

The whole subject received a thorough revision by Goursat (in the *Annales* de l'École Normale Supérieure, Sér. ii. t. x. 1881), who shows that in some cases the linear relations between the three integrals do not possess the same form throughout the whole of the plane of the complex variable. There still remains, however, for future researchers the discovery of an algebraic demonstration of such equations as the linear relation between

$$F(\alpha, \beta, \gamma, x), \; x^{1-\gamma} F(\alpha-\gamma+1, \beta-\gamma+1, 2-\gamma, x),$$

and

$$F(\alpha, \beta, \alpha+\beta-\gamma+1, 1-x),$$

series proceeding respectively according to integral powers of x, non-integral powers of x, and integral powers of $(1 - x)$, where, however, the last series cannot be expanded in integral powers of x.

The following details may be noticed:—

I. There is some obscurity in the explanation given in the note to Art. 25.[1]

If the system of curves $f(x, y, c) = 0$ have a node-locus let the node on the curve $f(x, y, a) = 0$ be given by $\xi = \phi(a)$, $\eta = \psi(a)$.

The node-locus will be found by eliminating a between the last two equations. The point to be explained is the reason for the appearance of this locus as a factor in the equation $\text{Disct}_c\ f(x, y, c) = 0$.

The coordinates of the node on the curve $f(x, y, a+\delta a) = 0$ may be called $\xi + \delta\xi$, $\eta + \delta\eta$. Then the following equations hold:—$f(\xi, \eta, a) = 0$, $\frac{\partial f}{\partial \xi} = 0$, $\frac{\partial f}{\partial \eta} = 0$; and the equations which can be obtained from them by changing ξ, η, a into $\xi + \delta\xi$, $\eta + \delta\eta$, $a + \delta a$ respectively. Of this last set of three only the first is required, viz. $f(\xi + \delta\xi, \eta + \delta\eta, a + \delta a) = 0$. Neglecting quantities of the second order, and using the preceding equations, it follows that $\frac{\partial f}{\partial a}\delta a = 0$. Hence the values $\xi = \phi(a)$, $\eta = \psi(a)$ satisfy $\frac{\partial f}{\partial a} = 0$, as well as $f = 0$, and therefore the node-locus is a factor of $\text{Disct}_c\ f(x, y, c) = 0$.

II. The properties of the Schwarzian derivative (Art. 62) may be thrown into a more symmetric form, viz:—

$$\{s, x\}(dx)^2 = -\{x, s\}(ds)^2$$

$$\{s, x\}(dx)^2 = \{s, y\}(dy)^2 + \{y, x\}(dx)^2$$

$$= \{s, y\}(dy)^2 + \{y, v\}(dv)^2 + \{v, x\}(dx)^2.$$

III. In Art. 192, the argument may be stated thus:—

It is given that

$$\frac{\partial\left[\frac{\partial F}{\partial \xi}, \frac{\partial F}{\partial \eta}\right]}{\partial[\xi, \eta]} = 0.$$

From this it follows that

$$\frac{\partial\left[\xi\frac{\partial F}{\partial \xi} + \eta\frac{\partial F}{\partial \eta} - F, \frac{\partial F}{\partial \xi}\right]}{\partial[\xi, \eta]} = 0.$$

Hence the equation of the tangent plane to the surface $z = F(x, y)$, viz. $z = x\frac{\partial F}{\partial \xi} + y\frac{\partial F}{\partial \eta} - \left(\xi\frac{\partial F}{\partial \xi} + \eta\frac{\partial F}{\partial \eta} - F\right)$ can, by putting $\frac{\partial F}{\partial \xi} = \lambda$, be expressed in the form $z = \lambda x + y\phi(\lambda) + \psi(\lambda)$, so that it is expressible in terms of a single arbitrary parameter λ. The quantities $\xi, \eta, \frac{\partial F}{\partial \xi}, \frac{\partial F}{\partial \eta}$ are not all functions of a single parameter.

IV. The solutions of Laplace's equation, which have

[1] The word "discriminant-equation" in the fourth line should be "differential equation."

been discovered since the second edition of this book was printed, and in which the author has himself borne an honourable part, are, if we except an example very near to the end of the book, not mentioned.

THE MAGNITUDE OF THE PROTEINIC MOLECULE.

Die Grösse des Eiweissmoleküls. By Dr. F. N. Schulz. Pp. viii+106. (Jena: Gustav Fischer, 1903.) Price 2.50 marks.

THIS work is the second part of the author's "Studien zur Chemie der Eiweissstoffe"; the first part is entitled "Die Krystallisation von Eiweissstoffen und ihre Bedeutung für die Eiweisschemie," and is also published by Gustav Fischer.

The book is composed of five chapters. The first deals with elementary composition as a measure of the magnitude of the proteïnic molecule, and fills twenty-four pages. In it the author discusses firstly the ash of proteïns. This he divides into essential and non-essential parts, without predicating chemical essentiality of the former. He concludes that the ash is of no value for the purpose under consideration. He deals next with the sulphur, and shows that it can be used to give minimal values. It is pointed out how the difference in the ease of its elimination affects the results, and the methods of its determination are discussed.

In the second chapter the products of substitution are considered. This chapter contains fifty-three pages. Of the natural bodies oxyhæmoglobin and caseïn are the only ones lending themselves to calculation. Consideration of artificial products yields no figures of value at present. The substances resulting from association of acids and bases with proteïns are not as yet available for purposes of calculation. The same may be said of those of metals with proteïns, with the possible exception of Harnack's copper-albuminates. The author points out, however, that these substances need closer study.

In connection with these bodies the author diverges into a consideration of certain properties of colloids, and indicates that associations of colloids may simulate chemical compounds. He states emphatically that use of such words as *combination* and *compound,* in the case of certain proteïns and proteïnic derivatives, may be unwarranted:—

"Eine Hauptaufgabe dieser Abhandlung war es gerade, dass gezeigt wird, dass bisher *keine zwingenden Gründe* vorliegen, um z. B. bei den Metallalbuminaten, oder später bei den Halogenalbuminaten, Verbindungen der Eiweissstoffe nach stöchiometrischen Gesetzen annehmen zu müssen."

The products of interaction of proteïns and halogens (especially iodine) are dealt with at some length. The absence of harmony in the results of different observers is shown, and the complexity of the process is pointed out. The conclusion is reached that these substances are not yet trustworthy for computational purposes.

The subject is regarded in the third chapter from the aspect of the products of hydrolysis, and it is found that no single compound is of use for the required calculation. The chapter contains nine pages

The fourth chapter, which consists of six pages, deals with physical methods, and chiefly with the cryoscopic one. The author has again to regard the results with suspicion, owing to the ash and the undefined nature of the substances. There is apparently an indication that the molecular masses of peptones, proteoses, and more complex proteïns stand to one another in a series of increasing magnitudes. The numbers attached to the two former classes may be of the right order; those connected with the latter are, however, valueless.

The final chapter, containing four pages, is devoted to conclusions. The author considers that the present state of the subject is very unsatisfactory, and that the molecular magnitudes of the more complex proteïns cannot be even given with approximate certainty. Selected minimal values, as those of Vaubel, lying for the more complex proteïns between 5000 and 15,000, can be made to give apparent harmony. But, if selection is not made, the result is very different.

The necessity of starting with crystalline bodies, and of improved methods is emphasised. The author also lays stress on the necessity of studying proteïns in their colloidal aspect, saying:—

"Ich bin der Meinung, dass eine gründliche Erforschung der colloidalen Eigenschaften der Eiweisskörper, das Räthsel der Eiweisschemie eher aufklären wird, als eine detaillirte Untersuchung der Krystallinischen Eiweissspaltungsproducte."

He adopts throughout a position of impartial criticism, which is eminently sound. The results hitherto obtained have for him no great positive value at present; this he attributes to insufficient precision in the modes of investigation, although admitting that the cause may be inherent in the proteïnic nature.

Some might urge that publication is in these conditions premature. But in the present state of proteïnic chemistry such a pamphlet as this, permeated with sane criticism, and summarising what is known in a clear and agreeable manner, can only be of value. The just appreciation of the extreme importance of a study of the colloidal nature of proteïns is a main feature of the work.

It is a regrettable fact that no index of subject-matter is appended, although there is one of authors, and a table of contents.

F. ESCOMBE.

PHYSIOLOGICAL REPORTS.

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Edited by Sir John Batty Tuke, M.D., and D. Noël Paton, M.D. Vol. viii. (Edinburgh: Oliver and Boyd, 1903.)

THIS volume represents the work done in the laboratory in 1900 and 1901, and though a year late in its appearance is none the less welcome for that. Apart from one paper on the pollution of the Tyne Estuary, it is devoted to pathology and physiology.

Throughout there are records of the energy and helpfulness of the superintendent, Dr. Noël Paton, and no less than one-third of the articles are by him, either alone or in conjunction with others. Indeed, his

interests are perhaps too multifarious, for one or two of his papers seem to have come into print before the observations they contain were ripe for publication.

Nothing, however, could be more elaborate or painstaking than the opening article, a study of the dietary of the labouring classes of Edinburgh, of which the expenses were partly defrayed by the progressive Town Council. The details were procured by a band of lady students, and are often amusing if not always essential. Thus we are glad to learn that a lady who dresses "in the Canongate fashion of a loose blouse" gets on well with her neighbours, but tragic possibilities follow on our introduction to the husband; "Mr. T. is not a teetotaler and he smokes."

The most interesting result of the study is the startling discovery that porridge is rapidly disappearing as a staple article of diet with these people. In fact, the investigation might have been entitled "A Plea for Porridge," for the authors rightly insist upon its economic value.

Of the other articles, the longest is a contribution to the histology and metabolism of the fœtus and placenta of the rabbit, by Dr. Chipman. With so difficult a subject, and so confused a terminology, the author's lucidity of style is very welcome, and the illustrative microphotographs, numbering no less than 186, are eloquent of his sincerity. He throws light on many controversial points, *e.g.* the manner of first contact of the embryonic and maternal tissues, the "unequivocal differentiation" of these two tissues, and the relations of placental and fœtal glycogen. It is a pity that he says nothing of the glycogen in the fœtal muscles, where it is said to exist sometimes to the extent of 40 per cent. of the dried tissue. There is much about the formation of "fibrinous tissue" from extravasations of blood, but he ligatured the vessels at the outset to ensure, as he explains, an injection of the placentæ, and we would suggest that these extravasations may have been, in part, an artefact.

Dr. Rainy's paper on the action of diphtheria toxin on nerve cells is so excellent, so far as it goes, that we look forward to a further instalment next year. He obtains very definite intracellular effects, and avoids error by a most thorough series of controls. Also he gives an admirable history of the subject.

There are many other minor articles of varying value. Dr. Carmichael, working at the infections of the gall-bladder, injected microorganisms into a mesenteric vein in five rabbits, and since he gets but one positive result, he concludes that infection can occur only by direct extension or by the cystic artery; of such factors as the virulence of the organism, the nature of the animal, and the condition of the gall-bladder he takes no account.

We are glad to see that Miss Huie is continuing her observations on the histology of cell-metabolism which she began so successfully in Oxford. Dr. Dunlop, in some observations on prison diets, confirms Atwater's finding that Voit's classical standard of diet is too low. Finally, we would mention a curious study by Dr. Berry in comparative morphology, in which he concludes that the vermiform appendix is not vestigial but the summation of a long development.

OUR BOOK SHELF.

An Elementary Treatise on the Mechanics of Machinery, with Special Reference to the Mechanics of the Steam Engine. By Joseph N. Le Conte. Pp. xi+311; with 15 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1902.) Price 10s. 6d. net.

THE author states that this book is the outcome of a series of lectures given to engineering students in the University of California.

In an introductory chapter relating to uniplanar motion, some properties of instantaneous centres and centrodes are given, and methods are set out of determining relative velocities, both linear and angular.

The next part is devoted to machinery of transmission, comprising rigid and flexible couplings, friction gearing, belt and rope gearing, and toothed gearing, the shafts being parallel, intersecting, or crossing, respectively. This part also includes chapters on parallel motions and cams.

The author has a leaning towards analytical rather than graphical treatment, and prefers accurate and complete investigations to simplified approximations. This is apt to result in formulæ which convey little meaning, and which repel by their complexity, requiring the subject-matter to be of great importance to justify their use. Thus in the discussion on wheel teeth there is an investigation into the equation to the profile which shall correspond with any given curve of action; and formidable expressions are given for calculating the angles of action in cycloidal and involute teeth. We should like to have seen these supplemented by graphical methods, using tracing paper and a pricker, after Mr. Last, whereby wheel teeth can be set out with perfect accuracy, with the minimum of trouble, and in such a way as to bring very prominently into notice the nature of the action between a pair of teeth.

Part iii. deals with the steam engine, the first chapter relating to the kinetics of the "piston-crank chain." Accurate formulæ are established giving the position, velocity and acceleration of any point moving with the connecting rod referred to the crank position, from which are deduced the special values for the centre of mass, the crosshead and crank pin. Formulæ for angular motions of the connecting rod are also given. In this chapter the simple and gridiron slide valves are considered, and also the Meyer and Thompson gears, Zeuner's valve diagram being used along with the formulæ.

Chapter ii. of this part is taken up with the dynamics of the steam engine, and investigates piston and crank efforts, inertia effects, counterbalancing, and the actions of the fly-wheel and governor. The formulæ of the preceding chapter are used to calculate the force actions in a small horizontal engine due to acceleration of the connecting rod for a number of points in the cycle; these are tabulated, and the results plotted in plates at the end of the volume.

In the mechanics of the steam engine, the use of the Fourier development, with the conception of rotating vectors, is preferable to the method adopted by the author. The series converges so rapidly that it is seldom necessary to go beyond the second or octave term, and a very clear view is obtained of the secondary actions due to obliquities of the connecting and eccentric rods.

The principle of balancing the forces on the crankshaft of an engine, ignoring those on the frame, is novel, and leads to curious results in the case of the Southern Pacific locomotive selected by the author as an example.

The investigation of the action of fly-wheel governors seems very complete, and is worth study.

Elementary Chemistry. By R. H. Bradbury, A.M., Ph.D. Pp. xii+157. (New York: Appleton, 1903.)

THE volume, according to the author, is for beginners in secondary schools and colleges. Whether this implies any previous knowledge of chemistry on their part is not stated, but, to judge from the character of the contents, the book may be placed in the hands of any beginner. The author has evidently taken great pains to arrange his subject-matter, and to present it in a simple and logical form—not by any means an easy task—and the result is decidedly good.

It is always possible to find points in the arrangement of a text-book which do not accord entirely with one's own views. For example, the first chemical experiment which is described is the electrolysis of water to demonstrate its composition. It is difficult to present this process honestly to the beginner. The author does his best by stating that "it is impossible to explain the *rôle* of the sulphuric acid in an elementary work, further than to say that while it conducts the current it is found unaltered after the experiment, and only the water is decomposed." After all this is only dodging the difficulty, which might be so easily avoided by reserving the experiment for a later stage, when the author could take the reader into his confidence.

The author in his preface acknowledges his indebtedness to Bancroft's work on the phase rule and to the work of another modern writer on physical chemistry, but the elementary student will be relieved to find that no reference to the phase rule, and very little to "physical chemistry," is embodied in the text. Arrhenius's theory of electrolysis is, however, introduced, and there can be little objection to this, seeing that a student may just as well begin to exert his imagination on the atoms in solution as in the gaseous form. It is just as difficult to form a mental picture of charcoal as a constituent of carbon dioxide as of the ion CO_3. The only difference between the two conceptions is that one is a demonstrable fact and the other a very useful fiction.

An important feature of the book is the experimental part which is to be used as a laboratory guide, and contains a series of simple and useful experiments plentifully sprinkled with questions and notes of interrogation. The volume is, in reality, two distinct books with separate indexes. Might one suggest their future publication in separate parts; for not only is it difficult to remember that the index to the first part is in the middle of the volume, but as the second part is for use in the laboratory, the whole book, which looks very nice in its olive-green cover, is bound to suffer from the proximity of reagents?

The book is well illustrated, and is further embellished with the portraits of ten distinguished chemists, among whom Moissan has the place of honour in the frontispiece. J. B. C.

Hampshire Days. By W. H. Hudson. Pp. xvi+344; illustrated. (London: Longmans, Green and Co., 1903.) Price 10*s*. 6*d*.

THE author of "The Naturalist in La Plata" has found a thoroughly congenial subject in Gilbert White's country, and discourses, in the work before us, in a delightfully gossipy way of the scenery, people, birds, insects, and plants of one of the most beautiful of all English counties. As usual, Mr. Hudson introduces, when occasion arises, earnest trains of thought, which raise his work far above the average of writings of this nature.

The greater part of the contents of this volume, we are told in the preface, is new, although nearly the whole scope of the work is based on certain articles which have appeared in *Longman's Magazine*. Although devoted as a whole to Hampshire, the book, as might be expected, mentions many episodes which might perfectly well have happened in any other English county. Notable among these is the account of the manner in which a young cuckoo ejected the rightful occupant—a robin—of the nest in which the intruder was hatched, an action of which the author was fortunate enough to have been an eye-witness. Perhaps the most curious feature in this drama was the utter neglect of the ejected and dying robin by its parents. In another part of the same chapter the author directs attention to the prevalence of red in the coats of forest animals at the time that the autumn russet prevails in their surroundings. He has, however, omitted to mention that it is just before this season the red deer and the roe change their summer russet for their winter blue.

The account of Selborne itself is continued in the latter half of the book. Over the natural beauties of the village and its surroundings, the author, needless to say, waxes eloquent, although he is far from complimentary to the personal appearance of its inhabitants. After writing the sentence that "if you want to see, I will not say a handsome, nor a pretty, but a passably fresh and pleasant face among the cottagers, you must go out of Selborne to some neighbouring village to look for it," will the author, we wonder, venture to pay another visit? We cannot, perhaps, bestow greater praise on Mr. Hudson's "Hampshire" than by saying it is fully equal to the best of his earlier efforts. R. L.

Wörterbuch der philosophischen Grundbegriffe. Von Dr. Friedr. Kirchner. Vierte neubearbeitete Auflage von Dr. Michaëlis. Pp. vi+587. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1903.) Price 5.60 marks.

IT is always difficult to indicate exactly the value of a dictionary, and that difficulty is increased when for the vices of omission it pleads the virtues of brevity. A dictionary of philosophy is hardest of all to judge because of a certain inner conflict between the spirit of philosophy and the nature of dictionaries. If the publishers feel justified in saying that this book responds to a widely felt need, we must admit that a fourth edition seems good evidence. To judge from the book, that need is for brief epitomes of great doctrines and concise definitions of terms. Terms of art are a fit subject for the lexicographer, more especially such remnants of constructive ingenuity as "Häcceität," "Aseïtät," and the like. But philosophical concepts and theories are not so tractable; here brevity is an ambiguous virtue, and the more ambitious articles seem to be so planned as to have full significance only for the more advanced student who, on the other hand, would bring to the book all he found there. "Kantianismus," for example, occupies two-thirds of a page. Of "Hedonismus" in modern times we learn only that it is more modest than of yore; where the term explained is one in common use, the strictly philosophical significance is omitted; *e.g.* under "Liebe (ἔρως)," the Platonic and Neo-Platonic significance is unmentioned; the direction "Vgl. Dualismus" seems purely illusory. Biography does not come within the scope of this book, but the references are usually given with dates. At the end there is a "Zeittafel" which might well be useful. It seems a matter for regret that the terms of the "new psychology" have not been included; they might at least outrival "Buridans Esel" or "Krokodilschluss" as Grundbegriffe. Yet allowing for these limitations, the book is a praiseworthy effort; it is generally accurate, sensibly printed, and of a useful size. Such eccentricities as "Hutcheson 1609–1747" (p. 14) can be corrected by the reader from the "Zeittafel." The bibliography attempted in some articles is a good feature worthy of more development. G. S. B.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Psychophysical Interaction.

SINCE NATURE is read by many people beside physicists and mathematicians, it may be useful to state explicitly that a letter with a diagram, on p. 102, is erroneous and misleading.

For the same reason it may be desirable to remark distinctly, in opposition to a notion *apparently* suggested by several previous writers, that guidance or deflection of motion is not in the least contradictory of the principle of the conservation of momentum. For the rest, all the letters of importance which have recently appeared are in accordance with my views. OLIVER LODGE.

I HAVE followed with much interest the discussion opened in your columns by Sir Oliver Lodge's recent contention that mind directs but does not create energy. What is aimed at, as I understand it, by this distinction is the reconciliation of the activity and efficiency of mind with the mechanical laws of the conservation of energy and momentum. The distinction itself is, as is well known, as old as Descartes, being designed by him to meet the same problem as it presented itself to the thinkers of the seventeenth century. As is also well known, it was immediately disowned by his successors on the ground that guidance or direction of energy by the mind is an interference with the operation of material forces as the physicist is bound to conceive of them not less than the creation of it. Why is it more inconceivable that mind should alter energy or momentum than that it should interfere in any way whatever with the material world as a closed mechanical system? While to Sir Oliver Lodge it seems axiomatic that mind cannot produce energy, to others it has seemed equally axiomatic that it cannot resist or control it. It remains, therefore, for those who propose to revive the above distinction as a way of making the relation of mind to matter comprehensible to show by an analysis of the conception of control that the direction of physical energy by the mind is any more intelligible than its creation. Failing this, the problem they have sought to solve by means of this formula only returns in a deeper form. How is mental efficiency in any shape to be reconciled with fundamental mechanical principles? The purpose of this letter is to suggest a form of solution, somewhat different from that of Prof. Ward's in his "Naturalism and Agnosticism," which makes recourse to so ambiguous a distinction unnecessary.

Stated in its most general form, the problem is that of the operation of mind upon matter. Three answers have stood out owing to the authority of those who at different times have advocated them:—

(1) It has been held that mind and matter are each in its own sphere effectively operative, but that these spheres are wholly different. They never touch or intersect. Where there appears to be coincidence, as in knowledge or in the action of one upon the other, this is to be explained (if an explanation is insisted on) as the result of prearrangement. Except in the form of the working hypothesis of parallelism, no responsible thinker would probably accept this "dualistic" theory at the present time, and it need not further be considered.

(2) The second answer is that which explains mental activity as merely apparent. The really active forces are material. Consciousness is merely a by-product, standing to material forces as the steam which is dissipated in the air stands to the steam-engine—a sign of its operation, but itself contributing nothing to its efficiency. This "materialistic" theory is surrounded by difficulties which this is not the place to discuss, but which the present generation seems to be in the main agreed are insuperable.

(3) A third view remains which takes up the problem at an earlier point, and asks whether our difficulty is not a self-made one. If we set out from the existence of mind and matter as two entirely separate substances, there is, it must be admitted, no way in which we can establish any continuity or causality between them. On the other hand, if we reverse this assumption, and regard the conception of two worlds, a physical and a mental, as one that grows up within (it is not said created by) our experience, a way seems opened up out of the difficulty. The conservation of energy and momentum, and the determination of their direction by physical antecedents, are from this point of view conceptions which are forced upon us in our endeavour to interpret to ourselves one side or aspect of our experience—that which we call the mechanical. Within the area so describable they are universal, ultimate, admitting of no exception. But the mechanical is only one side of our experience. Besides mechanical energy there is life. The phenomena of life violate no mechanical law, yet open up to us a new aspect of our world, a new form of "energy." We may, indeed, try to "explain" life as only a more complex mechanism, and this has been a common device since the time of Descartes. But the present day tendency to recognise here a *transitio in aliud genus*, and to reject (as leading to confusion) the attempt to explain the fuller, more concrete reality by formulæ applicable only to the more abstract, seems to be founded on a truer insight. What holds of the relation of life to mechanism holds also of the relation of mind to life in general. Here also a new world opens up with laws of its own, no more identifiable with those of matter or organism than the system of mechanical forces which make up the movement of the billiard ball upon the table or the contraction of the muscles in the player's arm is identifiable with his acquired dexterity or his gaming ambition.

"But how," it may be asked, "does all this help us? Granted the world of Nature has these different 'sides,' we are no nearer understanding how any one side is connected with another, least of all how the 'world as will and idea' is connected with the world as matter and energy." It is just here that I wish to invite the physicist who may not have considered the question in this light to make an experiment with his ideas which may not hitherto have suggested itself, and when suggested may appear to him as ridiculous as an invitation to vary his outlook upon the universe in the interest of science by standing upon his head. The suggestion is that instead of starting, as probably he has been accustomed to do, from the presupposition that the entirely real and concrete is what is known as the physical world, and that everything else must fall into line as in some sense a product or reflection of it, he should start from his own experience as a whole—his mind and will as it exercises itself in the world of reality in general, including, of course, other minds and wills—as though this were the primary, most entirely real and concrete fact that he knows, and regard all else as comparatively abstract and secondary. The former view I invite him to consider for the time being as analogous to the old Ptolemaic astronomy, the latter as the Copernican. When he has done so I ask him further to consider whether the operation of mind on matter need any longer constitute the insoluble problem the older hypothesis made of it. Putting aside the question of the relation of our individual minds to the mind of the Creator, the single "real" activity is from this point of view that of a conscious will in presence of a universe which it is its one supreme interest to understand and adapt to its own ends of life and well-being. The condition of such understanding and adaptation is selection and abstraction; its one supreme law *divide et impera*. A fundamental division at which developing experience early arrives is that of an inner and an outer—a self and other. A subdivision of the latter, which it is not long in achieving, is into the material other and the mental other—the physical and the social world. In this way the division proceeds, but always into parts of a whole of which we must keep a hold and to which we must ever return wherever the danger threatens of becoming the victim of our own abstractions. Treated as an articulate part of the whole, each field falls into its place in the organism of experience—general philosophy being the attempt to state what that place is; when hypostatised into an independent reality, still more when mistaken for the whole it leads only to confusion. From the beginning of speculation the front of the offending has here lain with Matter. Philo-

sophy from the time of Plato has had its own way of meeting it on its own ground, and disposing of its exclusive claims. I do not write here in the interests of transcendentalism, but merely to invite the attention of physicists to a point of view which students of modern psychology have borrowed from it, and are now generally seeking to apply to the problem of the relation between mental and physical energy. J. H. MUIRHEAD.

Birmingham, June 9.

Seismometry and Gëite.

HAD Dr. Chree (NATURE, May 21, p. 55) referred to the various papers about earthquakes in the reports of the British Association commencing in 1847 by William Hopkins, in the now somewhat antiquated *Transactions* of the Seismological Society of Japan, and in very many other publications relating to earthquakes, he would have seen that his instructive remarks relating to the propagation of waves in an isotropic medium were but repetitions of information with which seismologists have at least a slight acquaintance, whilst the suggestion that the velocities of such waves have been regarded as having a direct connection with Young's modulus is incorrect.

In connection with Bessemer steel, Young's modulus was mentioned, but I do not see that it was referred to repeatedly (NATURE, April 9, p. 538). In 1897 Dr. Chree made an attempt to calculate Young's modulus and the bulk modulus for the earth, but the grist he used was so doubtful in character that his results are not convincing. From some source or other he discovered that wave velocities of 12·5 and 2·5 km. per second had been determined, and these were assumed to be V_1 and V_2 for compressional and distortional waves passing *through* the world. One, if not both of these, are based upon *arcual* measurements; they are incorrect at that, and the latter seems more likely to represent the velocity of a surface undulation rather than a quantity corresponding to V_2.

What I pointed out was that recent determinations of a quantity probably corresponding to V_1 find a simple explanation by the assumption of a core that is fairly *homogeneous* and of fairly *definite dimensions*, which is not the solution of the seismological problems attempted by Dr. Chree. The reference to elastic moduli was incidental.

The chief objection raised to the iron core is not that iron, as we know it, will not convey vibrations at the observed speeds, but that if we take such a core, gravitational and astronomical requirements appear to be such that it must have dimensions which do not altogether accord with the interpretation given to seismometrical observations.

What Dr. Chree tells us about the possible relationship between seismic disturbances and the movements of magnetic needles is as well known to seismologists as what he has to say about wave velocities. Many of the chief magnetic observatories of the world have compared their magnetograms with long lists of world-shaking and other earthquakes, and the results are to be found in the British Association Reports, 1888 and 1889. From Dr. Chree's own comparisons at Kew (British Association Report, 1888, pp. 229 and 231, &c.), the movements he discovered were, with two possible exceptions, of "the ordinary magnetic small wave type," which "go on for hours if not for days." My conclusion is that at Kew, Greenwich, &c., needles seem not to be disturbed at the time of large earthquakes in the manner in which they are disturbed at Bombay and other places. At these latter places, where the movement of needles apparently accompanying the passage of the large waves indicates a possible magnetic disturbance directly due to seismic causes, the inference I made was that at such places H.F. and $(g-\gamma)$ may be abnormal. As an illustration of the coexistence of the *three* phenomena we may take the following:—

	H.F. (c.g.s.)	$(g-\gamma)$ cm.	Earthquake effect on magnetic needles
Kew	0·18451 (1901)	+ 40 (1900)	Undisturbed.
Batavia	0·36752 (1898)	+136 (1894)	Disturbed.

Whether these coincidences are accidental or general, observations are yet required. JOHN MILNE.

THE VITALITY OF THE TYPHOID BACILLUS.[1]

THE object of hygiene is to prevent disease. It is therefore necessary that the factors in the causation and dissemination of disease should be understood in order that adequate preventive measures may be adopted. The living agents responsible for the production of infectious diseases when they are discharged from affected individuals may find their way back to the human body by a number of indirect channels. The water, the soil, or the food may at times harbour and transmit the germs of disease. The conditions under which these morbid agents exist in the outside world constitute one of the most important subjects of hygienic inquiry. It cannot be said with regard to this phase in the life-history of pathogenic organisms that our knowledge is as accurate or extensive as it is in other directions. This is due to the difficulties that stand in the way of such investigations. The germs of disease undergo an enormous dilution in the air, water and soil, whilst they tend to become lost in the crowd of similar forms already existing in nature. The facts so far support the view that the parasitic microorganisms possess a considerable amount of resistance to external influences, and that the links which ensure their conservation and retransference to man are numerous and varied. A typical example is the bacillus of typhoid fever. This organism may become widely distributed through the dejecta. It may contaminate a water supply and directly, or by the agency of milk, produce a fresh outbreak of typhoid fever. It may infect the soil, and through it a number of raw vegetable foods. Its presence has been detected in the sewage-fed oyster, whilst tainted dust and flies aid in the distribution of the organism.

In studying the distribution of enteric fever, a physical factor which has to be considered is the influence of cold on the vitality of the specific organism. The effect of low temperatures upon microorganisms generally has formed a subject of inquiry from time to time. The latest experimental work has conclusively shown that bacteria retain their vitality under the most adverse conditions of cold that it is possible to devise. Prof. Sedgwick and Mr. Winslow, approaching the subject from the hygienic point of view, have carefully studied the influence of natural and normal conditions of cold upon the typhoid bacillus in particular. Their experiments were carried out with special reference to the danger of conveyance of the disease in question by polluted ice, and with reference to the seasonal distribution of the disease. The matter was undoubtedly one that called for investigation, and notably in a country where ice and iced drinks are in such universal demand. The authors were unable to find any recorded evidence of a conclusive character as to the spread of typhoid fever by a polluted ice supply, although it has been a common opinion that ice might be an important source of infection for typhoid fever and other intestinal diseases.

The apparent purity of ice is deceptive. It is true that water in freezing undergoes a certain amount of purification. It loses, on conversion into ice, saline constituents, contained air, and a certain proportion of organic suspended matter. At the same time, it is not entirely freed from microbes. The figures quoted by Prof. Sedgwick and Mr. Winslow show that snow-ice may contain an average of more than 600 bacteria per cub. cm. Figures are also given to indicate the enor-

[1] Experiments on the Effect of Freezing and other Low Temperatures upon the Viability of the Bacillus of Typhoid Fever, with Considerations regarding Ice as a Vehicle of Infectious Disease" By William T. Sedgwick, Ph.D., Professor of Biology, and Charles-Edward A. Winslow, S.M. Instructor in Biology in the Massachusetts Institute of Technology (*Memoirs* of the American Academy of Arts and Sciences, vol. xii. No. 5, 1902.)

mous number of bacteria present at times in ice-creams—one of the highest records being seven millions in one cub. cm. The sources of danger in ice-creams are obvious, as they come from the spoons and vessels, and the persons and dwellings of the street vendors.

Laboratory experiments have confirmed the conclusion that a freezing process is not necessarily fatal to bacterial life. We have instances of bacteria multiplying at zero, and of their survival after a six months' exposure to the temperature of liquid air. It is not therefore surprising that the American observers were unable to secure a complete sterilisation of bacterial cultures by the freezing methods they employed. The question became therefore a relative one. What was the probability or likelihood of infection through ice in the case of typhoid fever? It would appear that about 90 per cent. of the ordinary water bacteria are eliminated by the process of freezing. The authors find that, in the case of a specific pathogenic organism such as the *Bacillus typhosus,* less than one per cent. survive simple freezing for a period of fourteen days. Complete sterility did not occur even at the end of three months, whilst a process of alternate thawing and freezing, if on the whole more fatal to the typhoid germs than a simple freezing, was equally unsuccessful in effecting an absolute sterilisation of the infected water. The reduction in the number of typhoid bacilli in chilled water was approximately as great as occurred in ice. The process of destruction proved to be a continuous one, whether it occurred above or below the freezing-point, and whether the experiments were made in water or in soil. A progressive reduction in the number of organisms occurred to the extent of about 99 per cent., and proceeded *pari passu* with the duration of the experiment. Cold exercises a disinfecting action as regards the typhoid bacillus, and in natural ice there is a supplementary purifying influence to be taken into account, as, at the time of freezing, 90 per cent. of the germs are thrown out by a process of physical exclusion. These are the main conclusions arrived at, and the authors find that they are in accord with the general result of experience, namely, that natural ice can very rarely be a vehicle of typhoid fever.

The research may perhaps fairly be described as a study of the death-rate of typhoid bacilli under adverse conditions, as furnished by cold. The percentage mortality, as a matter of fact, is such as might occur under the influence of light, a poor food supply, and disinfectant agents generally. It is therefore permissible to think that the danger of infection in the case of ice, if it is minimised, is not by any means abolished. A certain number of typhoid bacilli, as the experiments show, do remain alive, and these may, on rethawing, undergo a rapid multiplication outside as well as inside the human body. And it has likewise to be remembered that it is notoriously difficult to trace the exact channels of infection in sporadic cases of typhoid fever. The infection has at times occurred from the most unexpected quarters.

Prof. Sedgwick and Mr. Winslow have rightly drawn attention to the unfavourable conditions furnished by natural ice for the propagation of the typhoid organism. It is at the same time feasible to assume that ice may likewise act as a conserving agent, inasmuch as the cold, whilst inhibiting the growth of the typhoid bacillus, will equally prevent the multiplication of other competitive forms of life.

The experiments do not affect the general question of the persistence of life at low temperatures. If the temperature be sufficiently low to produce a complete anæsthesia of the cells, cold tends to act as a conserving agent on the typhoid bacillus and allied forms.

It only remains to commend the memoir of Prof. Sedgwick and Mr. Winslow to the attention of all who are interested in the epidemiological questions involved.

ALLAN MACFADYEN.

NOTE ON THE PROBABLE OCCASIONAL INSTABILITY OF ALL MATTER.

As a summary of my remarks at the discussion on Prof. Rutherford's most interesting communication on the subject of radio-activity to the Physical Society of London on Friday last, June 5, I beg to communicate the following:—

Consider an electron or other particle, of mass m and of negative charge e, revolving at speed u round the much more massive rest of an atom possessing an equal positive charge. The centripetal force between them is

$$\frac{mu^2}{r} = \frac{e^2}{\mathrm{K}r^2},$$

where the first r strictly is measured to the centre of gravity of the two bodies, and the second r is the distance between their centres; but taking these as usual practically equal for the lighter body, we get Kepler's law for the case

$$ru^2 = \text{const.} = \frac{e^2}{\mathrm{K}m} \qquad (1)$$

Larmor has shown ("Æther and Matter," p. 227) that an electric charge subject to acceleration radiates some of its kinetic energy, though the radiation becomes of prominent amount only when the acceleration is great; as, for instance, when kathode rays are suddenly stopped by a target. The "power" of the radiation, or the energy lost per unit time, is

$$\mathrm{R} = \frac{2\mu e^2\dot{u}^2}{3v} \qquad (2)$$

where $\dot{u}$ is the acceleration of the electric charge e, and v is the velocity of light.

In the case of steady circular motion, the only acceleration is normal or centripetal, viz.

$$\dot{u} = u^2/r \qquad (3)$$

but that is just as effective for radiation purposes as the tangential variety.

Hence, combining the three equations, we get, for the radiating power,

$$\mathrm{R} = \frac{2}{3\mu} \cdot \left(\frac{m}{e}\right)^2 \cdot \frac{u^8}{v^5} \qquad (4)$$

that is, a constant multiplied by the eighth power of the velocity of the rapidly moving particle: an expression which corresponds with what for ordinary molecular motions is known as Stefan's law, connecting radiation with temperature, *i.e.* with square of molecular velocity.

Now the radiation loss is equivalent to a resisting medium, and accordingly the revolving particle tends to move inwards towards its centre, and its speed to increase in accordance with equation (1). A slight increase in speed brings about a great increase in radiating power, as is shown by equation (4); wherefore the change, once appreciably begun, may be expected to go on rapidly, until presently the speed approaches the velocity of light. On the electric theory of matter, radiation or loss of energy must occur from every atom, and therefore it is only a question of time how long an atom shall last before it reaches this stage.

Directly this stage is reached another effect supervenes; the rapidly moving portion of the mass begins rapidly to rise in value, according to a complicated expression not yet quite fully worked out. This effect

is unimportant until the speed comes very near to the light velocity, but the mass becomes suddenly infinite or very great when the light velocity is attained.

I find it difficult to realise the full effect of this kind of increase of mass, that is to say, of mass intrinsically possessed by the moving body, and not accreted on it from outside stationary matter. The latter effect is familiar in raindrops and in viscosity of gases, and it tends to reduce relative motion; but no previous instance is known where the mass of the moving body rises because it is itself a function of velocity. It would seem that the momentum must increase, and must disturb the balance of forces holding the parts of the system together. In an extreme case it might happen that the lighter body would suddenly become the heavier, would behave as if it had encountered an obstacle, and would jerk the rest of the atom off; or, on the other hand, it might happen that the most rapidly moving portion itself, by reason of its sudden access of momentum, would break loose and proceed tangentially. In any case it appears likely that an atom at this stage would begin to break up, as observed experimentally by Rutherford and Soddy; in other words, the fact of electronic radiation seems to carry with it the liability to change or decay of all matter possessing an electric constitution; the change from one form to another being accompanied, as they demonstrate in many cases, by radio-activity—a phenomenon which Strutt finds widely diffused.

It is hardly necessary to direct attention to a sort of astronomical analogy to this, though governed by different forces, in the contracting or gradual collapsing of a nebula, with the occasional shrinking off of peripheral material as an unstable stage is periodically reached, in accordance with the rough approximation known as Bode's law, together with the strong radio-activity of the central mass, and the conversion of constitutional potential energy into heat.

A few more words on the increase of mass at the critical velocity:—The only expression for mass as depending on velocity which has met with any attempt at experimental verification, is the expression of Abraham supposed to be verified by Kaufmann by direct experiment on curvature of kathode rays. Taking this as a simple example of the kind of effect to be expected, viz.

$$\frac{m}{m_0} = \frac{3}{4\beta^2}\left(\frac{1+\beta^2}{2\beta}\log\frac{1+\beta}{1-\beta} - 1\right) \quad . \quad . \quad . \quad . \quad (5)$$

where β is the ratio u/v, the speed of an electric particle to that of light, and m_0 its ordinary purely electric mass for slow motions, we find that when an electron is moving with *half* the speed of light, its mass is only 1.12 times what it was when stationary. At *three-quarters* of the speed of light the mass ratio becomes 1.37, or little more than a third greater than its normal value. At *nine-tenths* of the light velocity the mass is still not doubled, being only 1.8 times m_0.

When within 1 per cent. of the light speed the mass is trebled, or, more exactly, multiplied by 3.28, and when within one part in a thousand of its limiting velocity, the mass is almost exactly quintupled.

For higher speeds, say within $1/n$th of the speed of light, or $u=(1-1/n)v$, n being great, the expression for the electric mass ratio simplifies to

$$m = \frac{3}{4}\left\{\log(2n-1) - 1\right\}m_0 \quad . \quad . \quad . \quad . \quad (6)$$

which ultimately is truly infinite, but for even excessive values of n is only moderately great.

It is notable how close to the velocity of light it is necessary to get before this effect becomes prominent; the instability must be expected to arrive sharply whenever the velocity of light is from any cause, *e.g.* perturbation or collision, attained by any moving electrically charged part of an atom. Assuming a Maxwell distribution of velocities and an average speed, for the internal atomic motions, it may be possible (as J. J. Thomson suggested in NATURE of April 30, p. 601) to calculate what percentage of a given number of atoms reach the unstable stage by this means, and so to make a theoretical estimate of the amount of radio-activity to be expected, and of the life of an atom. But the slight constant radiation-loss seems competent to bring about instability and decay irrespective of collisions, and therefore independently of any Maxwell-Boltzmann law.

OLIVER J. LODGE.

PHOTOGRAPHS OF SNOW CRYSTALS.

At the beginning of last year (vol. lxv. p. 234) we summarised a paper contributed by Mr. W. A. Bentley to the U.S. *Monthly Weather Review* upon his photomicrographs of snow crystals. Mr. Bentley has made a study of the forms of snow crystals for more than twenty years, and has obtained a most valuable collection of photomicrographs taken with the object of discovering the connection between characteristic forms and particular meteorological conditions. During the winter of 1901–1902 a systematic record was secured by Mr. Bentley of a number of snow storms, and several good photomicrographs from each storm were obtained by him, more than two hundred pictures being added to his collection. The annual summary of the *Monthly Weather Review* for 1902 (vol. xxx. No. 13), which has just been received, contains reproductions of these photomicrographs and a paper by Mr. Bentley describing the various types of structure and the meteorological conditions prevailing at the time when they were produced. The paper contains an instructive account of snow crystals, and an analysis of the results of the studies carried on during the winter of 1901–1902. The interest of the pictures lies not merely in the fact that many of the forms photographed are very remarkable, but that they also represent, so far as possible, stages in the life-history of snowstorms, several pictures having been obtained of each storm, while at the same time a record was kept of the conditions of temperature, pressure, wind, cloud and position of storm from which the snow fell.

We print a few extracts from the contribution and reproduce several photomicrographs of exceptional interest from those given in the *Monthly Weather Review*.

In general the data tend to confirm further the conclusions of all observers, that a more or less intimate connection exists between form and size of nuclei, and the altitude and temperature of the air in which the crystals form. There can be no longer any doubt that there is a general law of distribution of the various types of crystals throughout the different portions of a great storm. On this point the data secured, both by direct observation and by a study of the weather maps, are much more complete and satisfactory than has hitherto been published. This aspect of our study received special consideration, because it was thought to be most important.

Snowstorms often cover a region of vast extent; crystallisation is going on within them over nearly the whole area, and therefore in regions that differ greatly among themselves as to temperature, humidity, air density, electrical conditions, &c. Moreover, the kind, number, dimensions, altitude and density of the clouds within those various regions differ so greatly one from another that the snow crystals emanating from each region furnish us rare opportunities for observing and studying the effects of each of these various conditions upon the forms.

The results arrived at by a study of the data secured during the four winters of 1898–99 to 1901–2, inclusive, in regard to the relative frequency of occurrences of the various types and the apparent connection between size and form and the air temperatures, agree in general with the results arrived at by many other meteorologists and observers, both in Europe and America, as set forth in the work "Schneekrystalle," by Dr. G. Hellmann, Berlin, 1893.

Doubtless the actual connection between forms and sizes of snow crystals and the temperature and density of the air is much more intimate than our present knowledge would indicate, because our studies are based on air temperatures at the earth's surface, instead of in the cloud strata where the snow crystals form. The temperature may often be mild at the earth's surface when the crystals are developing at high altitudes where the cold is intense, and such crystals should be classed with those deposited during extreme cold.

Structure of Snow Crystals.—The beautiful details, the lines, rods, flowery geometrical tracings and delicate symmetrically arranged shadings to be found within the interior portions of most of the more compact tabular crystals, and

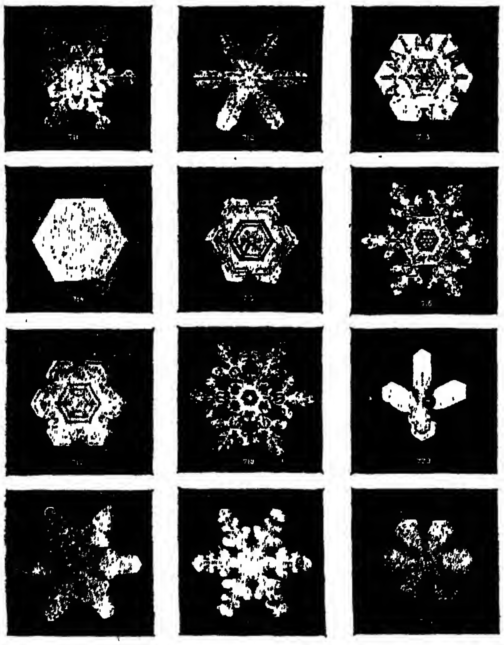


FIG. 1.—Nos. 711–724.

in less degree within the more open ones, have attracted the attention of nearly all observers who have studied snow crystals. That these interior details more or less perfectly outline preexisting forms must have been early recognised, yet the knowledge as to what they actually were remained long in obscurity, and a complete explanation of all of them is yet to be found. The investigations of Drs. Nordenskiold and G. Hellmann enable us to form a general conception as to their true character. These observers discovered that many of the lines, rods, and other configurations within the crystals, that add so much to the beauty of the forms, and which are so plainly revealed in the photomicrographs, are due to minute inclusions of air. This included air prevents a complete joining of the water molecules; the walls of the resultant air tubes cause the absorption and refraction of a part of the rays of light entering the crystal; hence, those portions appear darker by transmitted light than do the other portions. The softer and broader interior shadings may perhaps also be due, in whole or part, to the same cause, but if so, the corresponding inclusions of air must necessarily be much more attenuated and more widely diffused than in the former cases. We can only conjecture as to the manner in which these minute air tubes and blisters are formed. It may well be that some of them are the result of a sudden and simultaneous rushing together of water molecules around the crystal from all sides. This might result in the formation of closely contiguous parallel ledges, or laterally projecting outgrowths that are separated from each other during the initial impact by a narrow groove, or air space, but are soon bridged over by subsequent growth. Similar contiguous parallel growths occur frequently around the angles of very short columnar forms, and lend plausibility to this theory. Air spaces also exist within columnar forms, as noted by Hellmann and Nordenskiold. They seem to occur within such forms as hollow cup-like extensions, projecting perpendicularly within them from each of the ends of the crystals.

Modifications of Forms of Snow Crystals.—By close study of the photomicrographs, we find that the most common form outlined within the nuclear portions of the crystals is a simple star of six rays, a solid hexagon, and a circle. The subsequent additions assume a bewildering variety of shapes, each of which usually differs widely from the one that preceded it, and from the primitive nuclear form at its centre. Bearing in mind, however, the tendency of the crystals evolved within the upper clouds toward solidity, and the tendency of those from the lower clouds to form more branching open crystals, our task of deciphering the

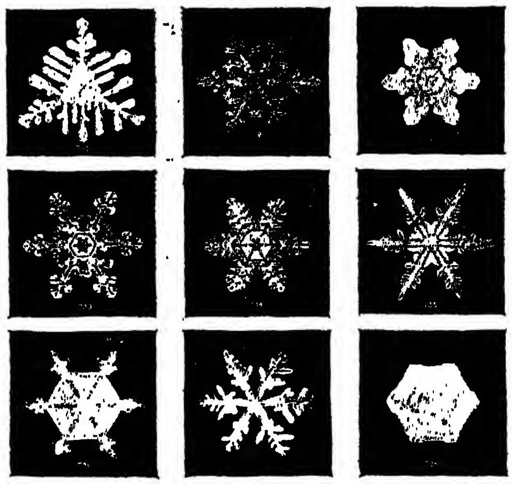


FIG. 2.—Nos. 730–738.

hieroglyphics, and of tracing thereby the probable flights of each individual crystal within the clouds, becomes much easier than might be anticipated.

Taking photomicrograph No. 821 as an example, we can picture with some certainty its various flights within the clouds during each stage of its growth. Star-shaped at birth, it was probably carried upward by ascending air currents, and at some upper level assumed the solid hexagonal form that we see outlined around the star-shaped nucleus. Having now become heavier, it probably descended, and acquired further growth at some lower level, such as that wherein it had its birth.

Modifications of Forms due to other Causes.—As it is generally conceded that winds play an important part in modifying the forms of snow crystals, let us consider the probable manner in which they operate to accomplish this.

Aside from causing modifications by wafting the crystals upward and downward within the clouds to regions varying in temperature, humidity, density, &c., as previously noted, the winds probably cause modifications in other ways. Violent winds may prevent a perfect and orderly joining of the aqueous molecules, causing imperfections in the forms, or perhaps amorphous, granular aggregations.

Again, they may waft greater quantities of water molecules to one or more portions of a growing crystal, causing abnormal growth to take place around such portions.

More important still, violent winds often cause fractures

to occur, especially as regards the branching forms, and whenever, as must often happen, subsequent growth takes place around and upon such broken crystals, irregular, unsymmetrical forms result. Doubtless, we may attribute the origin of some of the odd oblong crystals to the fact that crystallisation sometimes takes place around and upon a long broken branch, or other long portion detached by fracture from some preexisting crystal. Other odd forms seem to owe their abnormal character to design rather than accident. Columnar forms and, in a less degree, small solid tabular forms, being relatively so much heavier and more compact than stellar and similar branching forms, are much less likely than these to be wafted about and to receive modifications due to wind action.

Among the other causes of modification of forms, we must mention the close proximity of two or more crystals during one or more stages of their growth. This close proximity while developing would probably cause a greater growth of those portions of each contiguous crystal that lie farthest away from the crystal closely adjoining, and thus perfect symmetry would be impaired.

Considerable modifications of form are frequently due to the aggregation upon the crystals of amorphous or granular material, contributed by relatively coarse cloud spherules, particles of mist, or minute rain drops. Frail light, branching stellar and other forms are often rendered coarse and

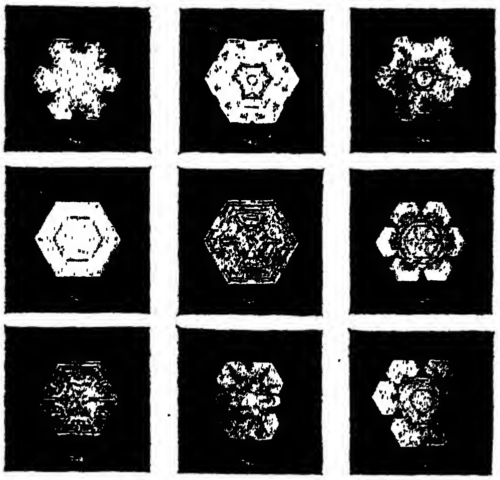


FIG. 3.—Nos. 742–750.

heavy by such additions taking place around and upon every angle of the crystals, so that they fall quickly to the earth.

Perfect crystals are frequently covered over and lines of beauty obliterated by such granular coatings. Granulation often proceeds to such a degree, and the true crystals are so deeply coated over and imbedded within it, that the character of the nucleus does not reveal itself, except under the closest examination. Such heavy granular covered crystals possess great interest for many reasons; they show when the character of the snow is due to the aggregation of relatively coarse cloud particles, or minute rain drops, and not to the aggregation of the much smaller molecules of water, presumably floating freely about between them. They also offer a complete explanation of the formation and growth of the very large rain drops that often fall from thunder-clouds and other rainstorms, if we accept the conclusion that such large drops result from the melting, or merging together, of one or more of the large granular crystals. For many reasons (among which we mention the almost invariable presence of low cloud strata when granulation occurs, and the aggregation occurring on perfect crystals, while these are presumably within the low clouds, rather than the occurrence of such aggregations as a distinct identity by itself) we are led to infer that, as a rule, the heavy granular covered crystals are peculiarly a product of the lower or intermediate cloud strata.

Chronological List of Snowstorms and Photomicrographs.—We now pass to the analysis of the photomicrographs of individual snow crystals secured during the remarkably

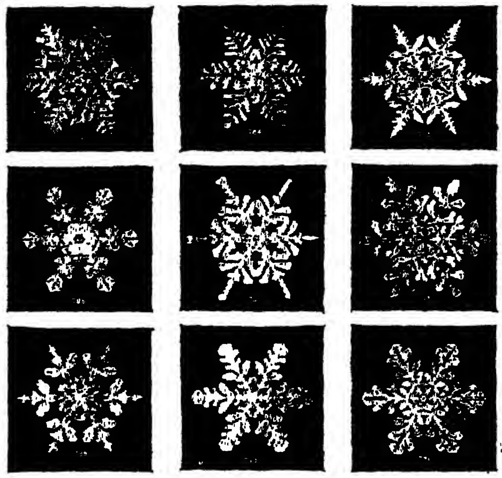


FIG. 4.—Nos. 783–791.

favourable winter of 1901–2. The number of individual crystals is very considerable, and the beautiful or odd and interesting ones form a large percentage of the whole number; many of them deserve special mention and prolonged close study. Considering them in chronological order, the snow forms of the blizzards of November, 1901, first demand our attention.

1901, *November* 26.—Eighteen different forms were photographed on this date, and among them two, Nos. 716 and 718 (Fig. 1), are very choice and beautiful. These exhibit a rather unusual and notable peculiarity, viz. a plain or delicately lined nucleus contrasted with a brecciated, boldly designed external portion; the latter approaching granulation, as though the nuclear portion was formed in clouds that were less dense and humid than those in which the outline portions were added. No. 712 is a fine example of the star-shaped form of crystal, exhibiting an extreme and slender development of the six primary rays without any corresponding development of the secondary rays. Many of the branching forms of this date were observed to be broken, as though by the action of violent winds.

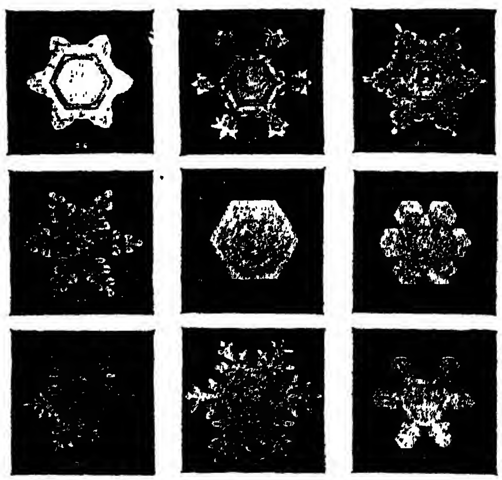


FIG 5—Nos. 816–824.

November 27.—Continuation of the same storm. Crystal types small, granular, and irregular, succeeded later by medium-sized, rather compact crystalline tabular forms and

a few doublets. Nos. 722 and 723 are charming patterns in snow architecture.

November 30.—Clouds rather thin stratus and nimbus. Crystal types wholly tabular of both open and stellate structure (Fig. 2, Nos. 730–737).

Among the seven forms of this date we find much to admire in the perfect beauty and symmetry of Nos. 731–734. The beautiful starfish design exhibited by No. 735 is somewhat rare. It is noteworthy that Prof. S. Squinabol, of the University of Padua, made drawings of a snow crystal found in Genoa in 1887 that closely resembles this latter one. The star with long slender rays deposited during this same storm, on November 26 (see No. 712), also closely resembles one figured by Squinabol in his work "La Navigata." No. 737 is another form that closely resembles some of those secured by other observers; it is very similar to some of the photomicrographs secured by Dr. Neuhaus, of Berlin, during the winter of 1893, and published in Dr. G. Hellmann's work.

December 4.—Clouds stratus, with detached running masses of low nimbus; probably high cirro-stratus above these. The western portion of this cold southern storm

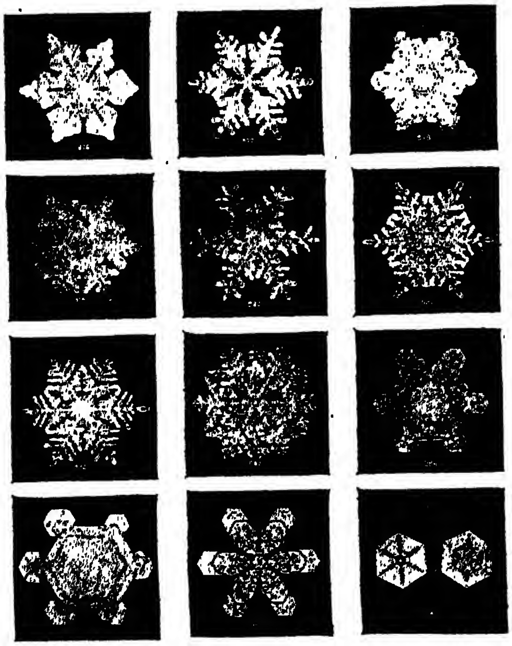


FIG. 6.—Nos. 876–888.

furnished a great number of forms of snow crystals that were in general rather small and compact.

The rare beauty of Nos. 745, 748 (Fig. 3) will appeal to all; crystallographers will find much of interest in No. 749.

1902, *January* 5.—The clouds of the western edge of the storm of January 5, 1902, furnished a large and splendid set of forms. Nos. 783, 785, 786, and 788 (Fig. 4) are exquisite examples of the frail, branching type of crystals. No. 785 is so rarely beautiful that Mr. Bentley describes it as the peer of any in his whole collection.

January 12.—Clouds obscured by heavy snowfall. A long series of magnificent snow crystals was secured from the clouds of the south-west-central portion of the storm or blizzard of January 12 (see Nos. 816–824, Fig. 5). The snow, as usual whenever it comes from the central-western portion of a storm, consisted of a great variety of types both columnar and tabular, but as the storm's central portion passed farther to the east, during the afternoon of January 12, the columnar forms ceased to be deposited. Nos. 818, 821 and 822 possess much beauty of design and perfection of form.

February 8.—Clouds stratus and nimbus; probably high cirro-stratus superimposed above them. A continuation of the storm of February 7, and its increase in rigour furnished more forms than were ever before secured by Mr. Bentley from any one storm. The beautiful branching crystals, Nos. 881 and 883 (Fig. 6), portray, in general, the characters of the forms that successively replaced both the solid tabular and columnar forms, as the western edge of the storm came nearer. No. 884 exhibits a most interesting phase of crystallic evolution; it is composed of four contiguous points, or rather portions, and two somewhat stunted portions, also similar to each other, but differing widely from the other four. No. 885 shows two overlapping additions to two of the points, thus rendering it of more than usual interest, and presenting us with another seemingly unsolvable problem in crystallography.

In concluding this mention of individual forms, it is worthy of note that, as during previous winters, occasionally single individual crystals, and more rarely larger numbers of such, produced during the storms of this winter, resembled closely, in outline or interior details, or oddity, one or more of the individual forms found among the snows of previous winters. The recurrence of similar types, after perhaps long intervals of time have elapsed, is a phenomenon of great interest.

In conclusion, it may be worth noting that by the addition of more than 200 plates during the past winter, the number of individual photomicrographs of crystals in Mr. Bentley's collection is brought up to somewhat more than 1000, no two of which are alike. This completes also his seventeenth year of photographic work among the snow crystals.

DR. A. A. COMMON, F.R.S.

IT was with deep regret that the news of the sudden death of Dr. Common had to be announced in the last number of this Journal. Dr. Common was so hale and hearty that it came as a great shock to his friends to find that he was no more, and his loss is felt not only by a great circle of friends, but by the astronomical world at large. Born in 1841, August 7, Dr. Andrew Ainslie Common was by profession an engineer, but quite at an early date he turned his attention to astronomy. In 1874 he became the possessor of a 5½-inch refractor, and three years later of an 18-inch reflector by Calver. It was evidently the use of the latter instrument which sowed the seed for his later important researches in the making and silvering of both large and small mirrors. An idea of his remarkable energy and success in the grinding and silvering of mirrors can be gathered from the following list of large reflectors in use which he referred to in his presidential address to Section A (Department of Astronomy) of the British Association in 1900. This list only referred to reflectors of 2ft. 6in. and upwards, and out of the nine given five were from his own workshop.

Reflectors of 2 ft. 6 in. and upwards.

	ft.	in.
Lord Rosse	6	0
Dr. Common	5	0
Melbourne	4	0
Paris	4	0
Meudon	3	3
Solar Physics Observatory (Common)	3	0
Crossley (Lick; Common)	3	0
Greenwich (Common)	2	6
Solar Physics Observatory (Common)	2	6

His knowledge of engineering was a valuable adjunct in the designing and construction of the mountings for his large mirrors. Dr. Common paid great attention to this latter question, for on it depended to a very great extent their efficiency and utilisation. He eliminated the "tube" by substituting a light framework of iron which reduced air currents to a minimum; adopted a new method to prevent the mirror being strained; mounted large mirrors equatorially by the ingenious device of reducing the friction of the moving parts by floating them in mercury; designed

and used successfully a slipping plate for use in the principal focus for photographic and visual purposes.

Not only was his time chiefly devoted to the construction of these astronomical instruments, but he turned them to great advantage by showing what could be done with them. Among the most noteworthy of these attainments was the magnificent photograph of the nebula of Orion which he secured in 1883, and for which he won the gold medal of the Royal Astronomical Society. Nebulæ, star clusters, &c., all came under his keen eye, and his researches not only demonstrated the cumulative effect of the photographic film, but showed that a new field of astronomical work was dawning by the employment of reflectors for long exposure photography.

More recently Dr. Common, among other things, turned his attention to the improvements in telescopic gun sights, and in this direction his loss will be keenly felt. He became a fellow of the Royal Astronomical Society in 1876, received the gold medal in 1884, and was president in 1895–96. He was elected a fellow of the Royal Society in 1885, and was an honorary LL.D. of St. Andrews.

Jovial, good-hearted, good-natured, and generous beyond degree in distributing his mirrors to those who would use them, all his friends join with the widow, son and three daughters whom he has left behind in mourning the loss of a personal friend.

WILLIAM J. S. LOCKYER.

PROF. C. A. BJERKNES.

IN NATURE of May 28 mention was made of the death of Prof. C. A. Bjerknes, of the University of Christiania, at the age of seventy-eight.

Though occupying the chair of pure mathematics, it was to applied mathematics, and especially to hydrodynamics, that Bjerknes devoted the greater part of his attention and study. He studied mathematics at the University of Göttingen early in the "fifties," his teachers including Riemann, who lectured on Abelian functions to a class of three only—Schering, Bjerknes and Dedekind—presumably between 1851, when Riemann obtained the doctorate, and 1859, when he was appointed ordinary professor, also Lejeune Dirichlet, who lectured to Schering and Bjerknes in 1855–56, and who proposed to them the problem of the ellipsoid in a steady fluid current. Solutions were given by both Schering and Bjerknes, but it was not until 1873 that Bjerknes completed his work on the problem of the general motion of an ellipsoid in fluid.

Bjerknes was at an early date attracted by the problem of replacing action at a distance by action of an intervening medium, and he exhibited considerable originality in the energy with which he took up the advancement of a doctrine which at that time received little support. The discovery that a sphere could move through a perfect liquid without retardation having shown that the existence of an ether does not involve a violation of Newton's first law, Bjerknes set to work to investigate the forces acting between two spheres moving in liquid, and in particular he developed the notion of "pulsating" spheres, *i.e.* spheres fluctuating periodically in volume, finding that between such spheres attractions and repulsions exist, obeying the law of the inverse square, and their sense being dependent on whether the phases are the same or opposite. The discussion of all the terms entering into the expressions for the forces was not completed until a comparatively late date, and in the meanwhile dynamical theories of physical phenomena have developed in other quarters, and ethers differing in their properties from ordinary matter, and in particular from matter in a fluid state, have come into existence. But another interest was aroused in these hydrodynamical attractions and repulsions by the experimental verifications of the results of the theory which were successfully carried out by both Prof. C. A. Bjerknes and his son, and of which we hope to give a fuller account shortly. These experiments were commenced in 1875, using rough and ready methods, but the apparatus have been gradually improved, and a number of papers on the subject were published, chiefly in the period 1878–1880, by Bjerknes and Schiötz in the Christiania *Forhandlinger*.

Among Bjerknes's other writings we note the biographical notice "Niels Henrik Abel; tableau de sa vie et de son action scientifique," published at Paris in 1885. Prof. V. Bjerknes has for many years collaborated with his father, and the second volume of his "Vorlesungen nach C. A. Bjerknes' Theorie" only appeared quite recently.

G. H. BRYAN.

NOTES.

MR. BALFOUR has accepted the presidency of the British Association for the meeting to be held at Cambridge in 1904.

PROF. RAY LANKESTER has been elected a Foreign Associate of the National Academy of Sciences, Washington, and a member of the American Philosophical Society, Philadelphia.

WE learn from the Paris correspondent of the *Times* that a monument, which has been erected by public subscription to the memory of Pasteur, was unveiled at Chartres on Sunday. This memorial specially commemorates the services of the great bacteriologist to agriculture by his discovery of a specific for anthrax, which resulted from a long series of experiments undertaken at a local farm. The principal feature of the monument is a high relief, which represents Pasteur and his assistants at work. It is the design of Dr. Paul Richer, who, besides being a member of the Academy of Medicine, is a distinguished sculptor.

A REUTER message from Simonstown, dated June 9, states that the German Antarctic ship *Gauss* arrived there on Tuesday morning after a successful year's work in the South Polar regions. She will remain there for three weeks to refit, and will then sail for home. On sailing from Cape Town the *Gauss* called at Kerguelen Island, and landed a party, which reached the floating ice on February 14, 1902. The ship was ice-bound on February 22 in lat. 66½, long. 90. New land was discovered, which was named the Emperor William II. Land. This was covered with ice, with the exception of an inactive volcano. The expedition was ice-bound here for almost a year, and many scientific investigations were carried out during this period. The ship left the ice on April 8 and proceeded to Durban, passing Kerguelen Island, and calling at St. Paul and New Amsterdam Islands. The members of the expedition enjoyed good health, there being no case of sickness, accident, or death during the whole cruise. Prof. Drygalski speaks in the highest terms of the vessel's behaviour, both in the sea and in the ice.

THE Hanbury gold medal has this year been awarded to M. Eugène Collin, École de Pharmacie, Paris.

A TABLET placed on the wall of Coate House, near Swindon, Wilts, the birthplace of Richard Jefferies, was unveiled by Prof. N. Story Maskelyne on June 6.

THE Vega medal of the Stockholm Society of Anthropology and Geography has been awarded to Prof. von Richthofen, of Berlin.

A NEW serum department of the Jenner Institute, at Elstree, will be opened on July 3. Dr. George Dean is the bacteriologist in charge of the department.

AN expedition in charge of Dr. F. A. Cook, of Brooklyn, is, says *Science*, to explore Mount McKinley and other Alaskan mountains under the auspices of the Geographical Society of Philadelphia and the Arctic Club, of New York.

THE Geological Society has made the first award of the proceeds of the Daniel Pidgeon fund, founded by Mrs. Pidgeon in accordance with the testamentary directions of her husband, the late Mr. Daniel Pidgeon, to Dr. E. W. Skeats, of the Royal College of Science.

THE Brussels *Bulletin Commercial* states that the Municipal Council of Lorient has recently decided to organise an International Exhibition of industry, agriculture, maritime defence, and fine arts, to be held from July to October of this year.

IT is reported that a young Austrian doctor named Sachs has fallen a victim to his scientific zeal, having accidentally inoculated himself with plague, from the effects of which he died after a short illness. Such regrettable incidents will occur while scientific research is pursued, and cannot be avoided even by the greatest foresight. There is no likelihood that other cases will develop, as under good hygienic conditions plague is not particularly infectious from man to man, and European doctors and nurses tending the sick seldom contract the disease.

THE wide distribution of typhoid-infected blankets that had been used in South Africa is another "regrettable incident" of the campaign, though those who made use of manifestly soiled blankets without washing them cannot be held blameless. On moist fabrics it has been proved that the typhoid bacillus retains its vitality for many weeks or even months.

Science announces that Prof. Florian Cajori, professor of mathematics at Colorado College, has been appointed representative of the United States on the international committee of the Congress for the Study of the History of the Sciences, which will make arrangements for the next meeting of the Congress at Berlin in 1906.

AT a meeting of the German Chemical Society on June 4 the presentation of the Hofmann foundation gold medal was made to Sir William Ramsay and to Prof. Moissan, of Paris. This medal is to be awarded once in every five years to a foreigner for distinguished chemical research work. The medal awarded to Sir William Ramsay bears on the obverse the effigy of Hofmann and on the reverse the inscription "For distinguished work in the field of general chemistry, and particularly for the discovery of new ingredients of the air."

BY the death of M. Eugène Demarcay at the early age of fifty-one, French science has suffered a severe loss. Although his earlier work was in the field of organic chemistry, his name is best known in connection with his researches on the chemistry of the rare earths. The magnificent specimens of pure salts of neodidymium, praseodidymium, samarium and europium shown by him at the Paris Exhibition of 1900 were the result of years of work of the most painstaking and laborious kind in a field in which he was one of the pioneers, and in which the number of workers is still too few.

AN Engineering Conference in connection with the Institution of Civil Engineers will commence on June 16 when Mr. W. H. Maw will deliver the eleventh "James Forrest" lecture on "Some Unsolved Problems in Engineering." On June 17 Mr. J. C. Hawkshaw, president, will inaugurate the conference with a short address to all the sections. The sections with their chairmen are as follows:—(1) Railways, Sir Guilford Molesworth, K.C.I.E.; (2) harbours, docks, and canals, Sir Leader Williams; (3) machinery, Dr. Alexander B. W. Kennedy, F.R.S.; (4) mining and metallurgy, Mr. E. P. Martin; (5) shipbuilding, Sir John I. Thornycroft, F.R.S.; (6) waterworks, sewerage, and gasworks, Sir Alexander Binnie; (7) applications of electricity, Mr. Alexander Siemens.

A PRACTICAL demonstration of the great power of the Marconi Wireless Telegraph station at Poldhu was given by Prof. Fleming during his lecture at the Royal Institution last week. A large mast had been erected above the Institution, and a complete receiving station set up; messages were received from Mr. Marconi, signalling from Poldhu, and also from a transmitting station at University College. All the experiments passed off without the slightest hitch. Prof. Fleming, in speaking of the future prospects of wireless telegraphy, laid stress upon the fact that there was a large sphere of usefulness open to it which submarine cables and land telegraphs could not touch.

IN the House of Commons on Monday Mr. Austen Chamberlain, speaking on the vote for the telegraph Services, referred at some length to the relations between the Post Office and the Marconi Wireless Telegraph Co. He said that the Post Office had no desire to check the progress of wireless telegraphy, nor could they have done so had they wished, as their monopoly did not extend beyond the three-mile limit. The Marconi Co. had, however, asked for too much; in the first instance they asked to be given a permanent and exclusive right to work wireless telegraphy in this country, which he could not grant, especially after the Post Office's experience with the telephone system. He had, however, granted them a private wire to Poldhu on the ordinary terms as soon as they asked for it, but before undertaking to act as their agents for the collection of messages, as was done for the cable companies, the Post Office required that certain conditions should be fulfilled in order to safeguard the Admiralty, and also asked that their experts should be satisfied that the company were able to carry on their business and transmit messages across the Atlantic commercially. He was still waiting an answer to this request, which was made last March. This statement does not quite tally with the accounts which were published last February, and were allowed then to pass uncontradicted. In any case there seems no reason why the Marconi Company should be required to pass an examination set by the Post Office; if people wish to risk sending messages by wireless telegraphy to America, they ought to be allowed full facilities for doing so; the Post Office by taking in the messages need incur no responsibility, by refusing to take them in it renders itself open to the charge of obstructing progress.

REUTER'S Agency is informed that a large number of foreign Government and technical delegates will be present

at the International Fire Prevention Congress which is to be held in London next month. The congress has been convened by the British Fire Prevention Committee, and will work in six sections, the papers and discussions being in English, French, and German.

WE regret to record the death, on May 30, of Mr. Alfred Haviland, aged seventy-eight. He had for many years devoted attention to the geographical distribution of disease in Great Britain, more especially of cancer and heart disease, having published maps and a separate volume on the subject.

WE learn from a cutting from the *Brisbane Courier* that Dr. J. P. Thomson, the hon. secretary of the Royal Geographical Society of Australasia, has left Brisbane on a visit to America, Great Britain and the Continent. At a meeting prior to his departure Dr. Thomson was invested with the powers of a delegate from the Australasian Society to all kindred societies in the various centres he may visit.

THE death is announced of Prof. Deichmüller, extraordinary professor of astronomy at Bonn University. From the *Athenaeum* we learn that he was born on February 25, 1855, and not long after completing his nineteenth year took part in the German expedition to observe the transit of Venus at Tschifu in 1874. Ever since October, 1876, he had been attached to the Bonn Observatory, and had shown skill not only as an astronomical observer and calculator, but also as a mechanician. He took a prominent part in the teaching at the University, and was made extraordinary professor of astronomy in 1897.

AN account of the life and works of the late Prof. Willard Gibbs is given in the Yale *Alumni Weekly* for May 6. It contains a portrait of Prof. Gibbs, and a chronological record of his principal published papers, together with a list of some of his academic distinctions and of the societies of which he was a member. Besides the papers which have done most to make his name known, Prof. Gibbs made important contributions in the domain of physical optics, notably in connection with the electromagnetic theory, but it is only by an exhaustive study of the papers themselves that his work can be adequately appreciated.

M. DE FONVIELLE writes that at the end of April a balloon belonging to the German Aëronautical Society left Berlin in the morning and landed at Skjolkör, in Seeland, in the afternoon, having crossed the Baltic in nine hours. The balloon was subsequently destroyed by a spontaneous explosion, the result of an electric discharge. The balloon reached an altitude of 4000 metres, where a temperature of -16° C. was registered. During the descent of the balloon the aëronauts observed crystals of snow falling in the car; the electricity generated by the formation of the snow had not had time to escape before the first impact with the earth, because the descent was very rapid. When the pilot took hold of the valve line an explosion occurred and ignited the gas of the balloon.

WE have received an advance copy of Merck's annual report for 1902 on advancements in pharmaceutical chemistry and therapeutics. It is a valuable and interesting summary of new preparations introduced for the treatment of disease, and should be in the hands of every medical man. It contains, in addition, notes upon many old remedies and the manner of prescribing them, together with a full bibliography.

IT is announced that Dr. Louis Martin, of the Pasteur Institute, Paris, has succeeded in preparing pastilles of an anti-diphtheritic serum for local treatment. The serum is an anti-microbic one obtained by the injection of dead diphtheria bacilli. These pastilles will not replace the injection of the serum, but will supplement the action of the latter, and during convalescence will remove contagion by destroying the diphtheria bacilli in the patient's throat.

MR. JONATHAN HUTCHINSON, F.R.S., has returned from his tour in India and Ceylon more convinced than ever of the correctness of his theory that leprosy is connected with the consumption of fish. In a letter to the *Times* (May 25) he states that there is no risk whatever from fresh or well-cured fish; the danger comes when decomposition commences. He points out that there is an excessive prevalence of leprosy among the Roman Catholic community in India, and suggests that the fast-day ordinances should be modified, also that the salt-tax should be abolished. The leprosy bacillus has never been found in fish, and Mr. Hutchinson does not explain how it is that fish becomes infective when stale.

MR. DAVID HOUSTON has examined bacteriologically a number of samples of Irish butter publicly exhibited, and concludes that a bacteriological examination will yield important information concerning the grade of any particular sample of butter. For example, one prize butter contained 260 spores of moulds per gram; the creamery was visited and the walls were found to be covered with a growth of mould. Another creamery sent a "preserved" sample and gained a prize. A specimen of the butter-milk taken from the churn was found to be crowded with putrefying and gas-forming bacteria, together with wild yeasts and moulds; a most undesirable state of things, and revealing why a "preserved" sample was exhibited.

IT has been stated by some authorities that the colon bacillus is normally present in the digestive tract of oysters. As this bacillus is undesirable in water used for drinking purposes, inasmuch as its presence may indicate the pollution of such water with sewage, it is not surprising that considerable interest has been aroused by its being reputed to be constantly present in the bodies of these molluscs. Mr. Caleb A. Fuller, of the Brown University, U.S.A., has endeavoured to throw fresh light on the subject by carrying out a systematic qualitative bacteriological examination of the digestive tract in the case of more than 2000 oysters. The specimens were taken from a bank which was free from any trace of pollution, and the colon bacillus was entirely absent from the adjacent sea-water. Sixteen different varieties of bacteria were isolated and examined, but not a single colon bacillus was discovered. This result would seem to indicate that oysters do *not* normally contain the *B. coli communis*, and that if it is found in their digestive tract, suspicion should fall on the breeding ground as having been exposed to pollution.

THE report of the Fernley Observatory, Southport, for the year 1902, shows that the work of this well-equipped establishment has been kept up to the usual high standard of efficiency. Mr. Baxendell does excellent work, not only in taking observations, but by instituting useful comparisons between various instruments and methods. The delicate records of the Halliwell self-registering rain-gauge give much satisfaction; this instrument recorded 641 hours of rain against 573 hours by another recording gauge. The comparison of the Campbell-Stokes and Jordan sunshine records gave only a difference of fifteen hours in the year in favour of the latter instrument, a much closer result in tabulating the records than some less careful observers might have reached. Several new tables have been added,

dealing with hourly results; one of these shows that the land and sea breezes are unusually marked at Southport, to an extent, the author remarks, of which meteorologists were not aware. The report contains the usual interesting comparison of climatological statistics with other health resorts.

THE Meteorological Office pilot chart for June shows that, as a result of the decision of the shipping companies to divert temporarily the steamer routes to the southward, there has been a great decrease in the number of ice reports from the southern extremity of the Newfoundland Bank. With the opening of the St. Lawrence season, however, reports from the northern part of the Bank are becoming more frequent. Another feature of the chart is an illustrated description of the violent storm of wind, rain and snow which, originating near Corsica, suddenly developed great energy on the evening of April 16, and starting off across north Italy, travelled through Austria and Poland to the Baltic and the Gulf of Bothnia.

THE twenty-second number of the pamphlet series issued by the West Indian Department of Agriculture forms part ii. of Mr. Maxwell-Lefroy's investigation of "The Scale Insects of the Lesser Antilles." It contains fifty pages of valuable illustrated information on a subject which is of the greatest importance to the colonists, as scale insects are becoming increasingly troublesome in some of the islands. The twenty-third pamphlet contains Mr. John Barclay's "Notes on Poultry in the West Indies." Hitherto the only information which the colonists had on the subject of poultry applied to countries well outside the tropics, but Mr. Barclay, of the Jamaica Agricultural Society, has for several years past devoted personal attention to the rearing of poultry in a tropical climate.

COMMANDER WHITEHOUSE, R.N., has, we learn from the *Times*, returned to England on sick leave from the survey of the southern portion of the Victoria Nyanza. With the recently inaugurated service of steamers round the lake the quickest route to the Tanganyika region will be by way of the Uganda Railway, and a project is on foot for opening a route from Lake Victoria to the north of Tanganyika to connect with the steamer on the last-named lake. Discoveries of gold are stated to have been made both in British and German territory along Lake Victoria, one being near the Lumbas Station of the Uganda Railway at mile 520, and the other in German territory to the east of Speke Gulf.

IN the course of a recent article published in the *Recueil de l'Institut botanique de Bruxelles*, Prof. Errera comes to the conclusion that it is not possible for organisms to exist of a size very appreciably smaller than those which can be observed with the highest powers of the microscope now in use. An estimation is made of the number of molecules of certain bodies, such as albuminoids, which are present in a bacterium of given size: the number is of such an order of magnitude that only a few molecules could be present in an organism having a diameter $0{\cdot}01\mu$, and thus a minimum limit to the possible size is obtained.

THE geology of Kalahandi State, in the Central Provinces of India, is described by Dr. T. L. Walker (*Mem.* Geol. Surv. India, vol. xxxiii. part iii.). The entire State is made up of unfossiliferous rocks, mainly crystalline schists, with occasional masses of laterite which cap the broad hills in the south-eastern part of the State. The occurrence of graphite, which may be of commercial importance, is noticed, and it is remarked that the graphite-bearing rocks may become diamond-bearing in places where they have been subjected to intense pressure. In sands from the streams near Bondesor, minute crystals, regarded as diamonds, have been detected.

ALTHOUGH several accounts of the cytological changes which accompany the formation of eggs in the Saprolegniaceæ have been published, the lack of agreement in details and conclusions made it desirable that further evidence should be obtained. This is forthcoming in the experiments and histological investigations which are recorded by Prof. B. M. Davis in the *Decennial Publications* of the University of Chicago. The experiments were conducted entirely with plants bearing oogonia only. A peculiar feature is the appearance of specialised masses of cytoplasm, the cœnocentra, round which the eggs are formed, and which influence the destiny of the nuclei.

A RECENT issue of *Psyche* contains the full report of a lecture by Mr. F. M. Webster on the "diffusion" of insects in North America. It is pointed out that this diffusion commenced far back in the Tertiary period, and attention is directed to the intimate connection between the insects of North America, northern Asia and Europe which existed at that epoch. Very remarkable is the fact that the modern Rhynchophora of North America agree more closely with their European Tertiary representatives than they do with those of their own country. All this indicates the probability of a former free intercourse between America and Asia, and perhaps also between America and Europe *viâ* the north-east. The lines of insect diffusion on the American continent are treated in some detail.

THE heredity of albinism forms the subject of a paper by Messrs. Castle and Allen published in the *Proceedings* of the American Academy. The experiments, which were made with mice, guineapigs, and rabbits, serve to show that albinism, at least in domesticated animals, is not, as often supposed, a sign of weakness and want of vigour. The important result is, however, the proof that albinism, as indicated by its disappearance for a generation and its subsequent reappearance under close breeding, is inherited in conformity with Mendel's law of heredity, and that, in the terminology of that law, it belongs to the category of recessive phenomena. For instance, in the case of mice, it has been demonstrated that the grey hybrids produced by crossing grey with white mice, when bred *inter se*, gave birth to grey and white offspring approximately in the Mendelian ratio of three to one.

IN the *Monthly Review* for June Sir Herbert Maxwell reviews the question of animal intelligence; that is to say, the psychology of animals other than man. Commencing with the declaration that he has nothing new to communicate, the author proceeds to observe that the problem resolves itself into three items. (1) Are animals born as automatons, and do they continue as such throughout life? (2) If they are conscious, are their consciousness and intelligence merely the physical products of certain changes which take place during development, and therefore spontaneous in the sense that the development of organic tissue is spontaneous? (3) Is the conscious intelligence esoteric, that is to say, due to the action of an external and superior mandate, or suggestion, acting upon a suitable physical receptacle? After relating a number of instances of animal behaviour bearing upon it, Sir Herbert considers it probable that the first question should be answered as follows, namely, that at birth animals are sentient and unconscious automatons, but that they are also provided with mental machinery ready to respond in a greater or less degree to

external impressions. In regard to the second question, evidence is adduced to show that, although the growth of the organ of consciousness may be considered spontaneous and congenital, yet that there are instances where the intelligence of individuals displays a forward movement which may have important effects upon the habits of the race. As regards the third question, the author observes that if it be unphilosophical to attribute to a certain species of moth a knowledge of vegetable physiology, "what is left but to speculate whether the First Cause be not also a Directing Power, with means of communicating his mandates to the humblest of his creatures?"

IN the current number of the *Bulletin of the American Mathematical Society*, Mr. E. B. Wilson reviews a very interesting work, Prof. G. Loria's "Ebene Curven," which ought to attract all classes of mathematicians. Besides giving an account (illustrated with numerous figures) of a large number of special plane curves which are of interest for historical or other reasons, Prof. Loria gives a summary of his memoir on panalgebraic curves. A panalgebraic curve is one for which x, y and dy/dx are connected by an algebraic equation; in this class are included a very large proportion of all plane curves which have hitherto been studied, and the fact that Prof. Loria has demonstrated a considerable number of geometrical properties common to them all is very interesting and remarkable.

MESSRS. DAWBARN AND WARD, LTD., have published a booklet by Mr. H. Snowden Ward entitled "Profitable Hobbies," containing much useful information upon manual work of various kinds which can be successfully performed by amateurs.

BY arrangement with Messrs. Kegan Paul, Trench, Trübner, and Co., Ltd., the Rationalist Press Association has published, through Messrs. Watts and Co., a sixpenny edition of J. Cotter Morison's "The Service of Man. An Essay towards the Religion of the Future."

IN the *Physikalische Zeitschrift*, No. 16, p. 457, Messrs. Elster and Geitel discuss the question of the cause of the electrical conductivity of the air in the neighbourhood of phosphorus undergoing slow oxidation. Experiments are described which indicate that the cloud rising from the surface of the phosphorus is not responsible in any way for the electrical conduction. It is also rendered probable by suitably devised experiments that the conductivity is really due to ionisation of the air in the neighbourhood of the phosphorus.

IN a recent investigation of the properties of colloidal solutions by Mr. H. Garrett, experiments on the viscosity of solutions of gelatin, silicic acid and albumin have been made which appear to throw considerable light on the nature of such systems. They behave like heterogeneous liquids composed of two solutions having a surface tension at the contact surfaces. At any given temperature the viscosity of these solutions is not constant, since this depends on the surface tension, and this again is a variable depending on the previous history of the solution.

A NEW refractory material, to which the name "Siloxicon" has been given, is now being manufactured on a large scale by the International Acheson Graphite Company at Niagara Falls. It contains silicon, oxygen and carbon, and is said to give most satisfactory results as a substitute for refractory clays, magnesia, lime and graphite in their application to high temperatures. The product is obtained by the action of carbon on silica at a temperature of 4500–5000° F. in the electric furnace, the quantity of carbon employed being insufficient for the complete reduction of the silica and its conversion into carbide. It is stated that in these circumstances compounds containing all three elements are obtained.

THE current number of the *Journal of Physical Chemistry* contains an interesting paper by Messrs. Miller and Kenrick on the subject of the identification of basic salts. The allocation of formulæ to basic salts is apt to be somewhat arbitrary, and there is no doubt that many of the "amorphous finely-divided precipitates" which have been endowed with formulæ and thus raised to the dignity of chemical individuality are nothing more than mixtures of different bodies in proportions dependent upon the conditions of preparation. The authors show that, at any rate for those precipitates the equilibrium of which with the mother-liquor is attained, the question of individuality can in many cases be solved by simple application of the phase rule. The considerations brought forward have been applied to establish the individuality of several basic salts which have been investigated.

IN the current number of the *Comptes rendus* there is an account, by M. P. Lemoult, of the preparation and properties of dibromoacetylene. Tribromoethylene, which is easily obtained in quantity by the action of sodium ethylate upon symmetrical tetra-bromoethanes, is heated with alcoholic potash in the absence of air, and the dibromoacetylene collected under water. The distillation has to be carried out in a current of nitrogen, as the substance is spontaneously inflammable in air. Dibromoacetylene cannot be distilled, even in a vacuum, and under certain conditions may explode violently. Bromine and iodine give rise to C_2Br_4 and $C_2Br_2I_2$ respectively, and cautious treatment of the ethereal solution with moist air or oxygen gives rise to oxalic and hydrobromic acids. The first action would appear to be the addition of oxygen resulting in the formation of oxalyl bromide, which is then acted upon by the water present in the usual manner.

WE have received from Mr. H. Kondo, director of the Taihoku Observatory, Formosa, valuable results of meteorological or rainfall observations made at fourteen stations in that island and in the Pescadores in the years 1896–1901, also a discussion of the observations (in Japanese) accompanied by diagrams showing very clearly the general characteristics of climate, tracks of typhoons, &c. We extract the following values for Keelung and Koshun, on the extreme north-east and south respectively; these are stations of the second order, but at the central observatory hourly observations are recorded. At Keelung the mean annual maximum temperature is 75°·7, minimum 66°·6; absolute maximum 94°·6 in July, minimum 37°·4 in February; mean annual rainfall about 150 inches. At Koshun the corresponding values are:—mean maximum 81°·7, minimum 71°·1; absolute maximum 92°·1 in July, minimum 49°·6 in February; mean annual rainfall about 92 inches.

THE additions to the Zoological Society's Gardens during the past week include two Grevy's Zebras (*Equus grevyi* ♂ ♀) from Southern Abyssinia, presented by Lieut.-Colonel J. L. Harrington, C.V.O.; two Leadbeater's Cockatoos (*Cacatua leadbeateri*) from Australia, presented by Lady Katherine Coke; two Eastern Sarus Cranes (*Grus antigone*), two Thurgi Terrapins (*Hardella thurgi*), a Batagur Water Tortoise (*Batagur baska*), twelve Long-fingered Frogs (*Rana hexadactyla*) from India, five Wall Lizards (*Lacerta muralis*, var. *melisselensis*) from St. Andrae, a Magpie (*Pica rustica albino*), British, deposited; two Common Camels (*Camelus dromedarius*, ♀ ♀) from the Soudan, purchased; a Red-fronted Lemur (*Lemur rufifrons*), two Japanese Deer (*Cervus sika*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE SOUTH POLAR CAP OF MARS.—In an article published in No. 4, vol. xvii. of the *Astrophysical Journal*, Prof. Barnard details the results of his observations of the South Polar cap of Mars made at Lick during the close approaches of the planet in 1892 and 1894. He made a series of micrometrical measures of the cap during each opposition, and the figures obtained during 1892 are set out in a table which accompanies the article.

Whilst looking over these measures recently it occurred to Prof. Barnard that if they were plotted with respect to the summer solstice of the Martian southern hemisphere some instructive results might be obtained. This was done, and the two curves, which are reproduced, show that the cap at both oppositions followed the same law of decrease with remarkable fidelity.

Another important point observed was that the cap appeared to diminish for some time after the summer solstice, that is to say, the highest temperature was not reached until several weeks after the maximum of solar heat; this may have an important bearing when discussing the existence of a Martian atmosphere similar to the earth's atmosphere.

In May, 1894, the Polar cap covered an area of about 365,000 square miles, by the end of November it had completely disappeared, thus showing that the snow, if snow it be, is not of any very great depth.

One remarkable phenomenon observed was the appearance of a projection from the edge of the cap in the same position and at the same period during each opposition; this remained behind as a bright strip, and seems to indicate the existence of a mountain range which is probably high enough to remain permanently snow-capped.

Eight drawings of the cap during each opposition, and a drawing of the whole planet, accompany the article, and show the details of the outline of the cap very clearly.

THE HARVARD PHOTOGRAPHS OF THE ENTIRE SKY.—In *Circular* No. 71 of the Harvard College Observatory, Prof. E. C. Pickering gives a description of the photographs taken at Cambridge (Mass.) and Arequipa, which have been obtained so as to furnish a bi-monthly record of the entire sky down to stars of the twelfth magnitude. Each plate measures ten inches by eight, and covers a region of more than 30 degrees square; they have been obtained with two similar anastigmatic lenses of one inch aperture and thirteen inches focal length.

Prof. Pickering explains how useful these plates have already proved at Harvard in determining changes of variable stars, the times of the first appearances of Novæ, &c., and states that in order to allow astronomical science generally to participate in these benefits, it has been decided to make negative copies on glass of one series of fifty-five plates, and distribute them to all who desire them at a price below cost. The whole set of fifty-five may be obtained for 15·00 dollars, and selected sets of ten for 3·00 dollars; the balance of the cost is being paid from the "Advancement of Astronomical Science" fund of the Harvard Observatory. Should the demand justify the experiment a second set, the centres of which are near the corners of the first set, will be issued later.

Prof. Pickering gives a catalogue of the plates it is proposed to issue, giving full particulars of the regions they cover, the dates of exposure, &c., and in a set of "remarks" appended to the catalogue he gives details of any special object each plate contains.

THE ROYAL OBSERVATORY, GREENWICH.

THE Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, was read at the annual visitation on Saturday last. From the record of work done during the year covered by the report, we select a few notes referring to the state of some investigations of especial interest.

Longitude Operations.—The second stage of the redetermination of the Paris-Greenwich longitude was completed in the autumn of last year. As in the first stage carried out in the spring and referred to in the last report, observations were made simultaneously by two French and two English observers at adjacent stations. The observations of both the French and English observers were made in three groups of three, six, and three full nights (or their equivalents in half nights), the observers with their instruments being interchanged between the first and second and again between the second and third parts. In the determination made in the autumn the stands were also interchanged with the instruments.

The reduction of the observations made by the English observers is completed with the exception of slight corrections which may have to be made in a very few instances to the assumed right ascensions of the stars.

The determination made in the spring of last year gave for the difference of longitude between Cassini's meridian and that of the Greenwich transit-circle 9m. 20·974s., and for the difference of personal equation $D-H=0·041$s. The determination made in the autumn gave 9m. 20·909s. and the difference of personal equation $D-H=0·049$s. In the first series, if the level determination had been based entirely on observations of the striding levels, the result would have been 9m. 20·982s., and if entirely on the observations of nadirs 9m. 20·969s. In the second series the difference between the results from "striding levels" and "nadirs" was only 0·002s. In the first series the probable error of the difference of longitude determined from one full night's observations was $\pm 0·040$s., and in the second series only $\pm 0·018$s., giving for the probable error of the determination made in the spring $\pm 0·0113$s., and for that made in the autumn $\pm 0·0047$s. In each series there was a double interchange of observers, so that the probable error includes any change of personal equation between the first and third parts, and this would appear to account to some extent for the larger probable error found for the first series.

The International Geodetic Association, considering it desirable that a redetermination of the difference of longitude Potsdam-Greenwich should be made with their lately adopted Repsold registering micrometer, the longitude pavilion was placed at their disposal, and the Post Office authorities have given all the telegraphic facilities desired. Prof. Albrecht and Herr Obst installed their instruments in the last week in April, and the observations are now in progress.

Lunar Tables.—The need for improved tables of the moon has been emphasised during the past year by the discussion of the results of Greenwich observations in the last ten years, which was taken up primarily in connection with the delimitation of an Anglo-German boundary, and may perhaps be advantageously extended with a view to its use in the formation of improved tables of the moon. In the same connection Prof. Newcomb, who has devoted so much attention to the subject, has urged that a fresh comparison should be made between theory and the Greenwich meridian observations from 1750 to the present time. It is a question for consideration whether it would be practicable to carry out this work at the Royal Observatory in such a form as would facilitate the preparation of improved tables and materially advance the lunar theory.

Stellar Observations.—The progress made in the observation of the reference stars for the astrographic plates, for which more than 10,000 stars are to be observed three times above and twice below pole, has been very satisfactory.

The observations of these stars were commenced in 1897 and will be completed at the end of 1906. In 6·35 years 63½ per cent. of the observations have been secured, of which 11½ per cent. were contributed in the last year. From a comparison of the observations above and below pole for the stars from N.P.D. 0° to 5°, which have been completely observed, it appears that the probable error of a catalogue place (five observations) does not exceed $\pm 0''·23$ in R.A. or N.P.D.

As the photography for the Greenwich Zone (Dec. +64° to the Pole) has been completed, only a few photographs have been taken with the astrographic equatorial to replace some which appeared to be inferior to the general standard. Altogether 116 photographs were taken during the year; these include 16 plates for the Astrographic Chart, 21 for the Catalogue, 48 of Nova Persei, 11 of Comet *b* 1902, 6 of Comet *a* 1903, and 8 for the adjustments of the instrument.

The counting of the Chart plates has been continued during the year, and completed between Dec. 64° and Dec. 70°. A paper on the statistics of the stars between 65° and 70° N. Dec. was communicated to the Royal Astronomical Society in January, and printed in the *Monthly Notices*.

The 28-inch refractor has been used throughout the year for micrometric measurements of double stars. The total number of double stars measured during the year is 381; of these 192 have components less than 1″·0 apart, and 105 less than 0″·5.

Series of measures have been obtained of κ Pegasi, δ Equulei, 70 Ophiuchi, and ζ Herculis. Capella has been examined at every favourable opportunity, and observations of the position angle of the elongated image have been secured on eight occasions.

Solar Activity.—Shortly after the date of the last report a long period of almost complete solar quiescence set in; from 1902 June 5 to September 17 inclusive, a period of 105 days, the mean daily spotted area was less than a single unit (one millionth of the sun's visible hemisphere). An active period set in on September 18 and lasted until November 28, 72 days, the mean daily area being 164 millionths. The rest of the year 1902 was very quiet, the remaining 34 days showing a mean daily area of only 3. In the present year the sun has been much more active, and has been free from spots on only 14 days since January 1, as compared with about 100 in the same period of last year. The first of a fine series of spot-groups appeared on the east limb on 1903 March 21, and a succession of new groups has followed almost without intermission up to the date of this report. There can be no doubt, therefore, that the solar activity is very decidedly upon the increase.

Tables and diagrams showing the distribution of sun-spots in latitude and the areas of sun-spots and faculæ compared with magnetic diurnal ranges for the 29 years 1874 to 1902 have been prepared, and will be published in the *Monthly Notices* R.A.S. for May.

Magnetic Observations.—The principal results for the magnetic elements for 1902 are as follows:—

Mean declination	16° 22′·8 West.
Mean horizontal force	4·0134 (in British units).
	1·8505 (in Metric units).
Mean dip (with 3-inch needles)	67° 3′ 25″.

Meteorological Observations.—The mean temperature for the year 1902 was 49°·1, or 0°·4 below the average for the 50 years 1841–90.

The rainfall for the year ending 1903 April 30 was 23·68 inches, being 0·86 inch less than the average of 50 years. The number of rainy days was 172. The rainfall has been less than the average for each of the eight years from 1895 to 1902 inclusive, the total deficiency for the eight years ending 1902 December 31 amounting to 28·91 inches. For the four months 1903 January–April there has been an excess of 0·95 inch.

THEORY OF CYCLONES AND ANTICYCLONES.

PROF. F. H. BIGELOW contributes to the U.S. *Monthly Weather Review* for February a paper on the mechanism of counter-currents of different temperatures in cyclones and anticyclones. An outline theory of the structure of cyclones and anticyclones was described in the report of the Chief of the Weather Bureau for 1898–1899 (vol. ii). It was evident, however, that a more complete insight into the mechanism of motions in a fluid such as air under atmospheric conditions would be afforded by the construction of systems of isobars on at least three planes having different altitudes. For this purpose, the sea-level and the levels of 3500 and 10,000 feet were selected, and since December, 1902, daily reduced pressures for these planes have been received from the regular observing stations of the United States and Canada, and charts have been constructed for them. The approximate gradients needed for a preliminary consideration of the subject have thus been obtained, and the general results of the investigation are stated by Prof. Bigelow as follows:—

(1) The cyclone is not formed from the energy of the latent heat of condensation, however much this may strengthen its intensity; it is not an eddy in the eastward drift; but it is caused by the counterflow and overflow of currents of different temperatures. Ferrel's canal theory of the general circulation is not sustained by the observations, nor is his theory of local cyclones and anticyclones tenable. There are difficulties with regard to the German vortex theory, but this is nearer the truth than the Ferrel vortex. The structure in nature is actually more complex than has been admitted in these theoretical discussions, but it doubtless can be worked out successfully along the lines herein indicated. (2) Regarding the relation of the upper level isobars to practical forecasting, it is noted as the result of the examination of charts that (*a*) the direction of the advance of the centre of the low pressure is controlled by the upper strata, and its track for the following twenty-four hours is usually indicated by the position of the 10,000-foot level isobars; (*b*) the velocity of the daily motion is also dependent upon and is shown by the density of these high level isobars; (*c*) the penetrating power of the cyclone is safely inferred from an inspection of the three maps of isobars of the same date; (*d*) there is decided evidence that areas of precipitation occur where the 3500-foot isobars and the 10,000-foot isobars cross each other at an angle in the neighbourhood of 90°; (*e*) there have been several cases in which the formation of a new cyclone has been first distinctly shown on the upper system of isobars before penetrating to the surface or making itself evident at the sea level. (3) It is expected that by completing our discussion of the temperature gradients between the surface and the higher levels we shall be able to secure daily isotherms as well as daily isobars on the upper planes, and this will tend to strengthen any further examination of these important problems. A suitable report will be prepared in which the data now coming into our possession will be subjected to a mathematical analysis and discussion.

ATMOSPHERIC VARIATIONS.

FROM the results of recent researches solar prominences seem to be playing a most important part, not only in the mechanism of the solar atmosphere, but in the variations of our own. Any investigation, therefore, that gives us new ideas or corroborates the old is most useful and valuable. In a previous number of this Journal (vol. lxvii. p. 569, April) an account was given of the results obtained from a research on the distribution of solar prominences as regards latitude. The prominence circulation thus disclosed that there was practically a law at work which the centres of prominence action followed, and this law, deduced from observations extending over the longest period available (1872–1901), was found to be in good agreement with that first suggested by Prof. Ricco in 1891 (*Mem. d. Soc. degli Spettr.*, vol. xx. p. 135). Prof. Bigelow has also been studying the question of prominence, facula and spot circulation, and in a recent number of the *Monthly Weather Review* (vol. xxxi. No. 1, p. 9) has stated his results. The method he adopted was somewhat different from the one first mentioned above, for the prominence circulation determined by him has been deduced by finding the mean variation of the prominence distribution resulting from coupling up together the values for those years which he considers are similar in relation to the eleven-year sun-spot cycle. Anyone familiar with this cycle knows the difficulty this involves, because it is only the mean length of the sun-spot period that is eleven years. Further, the epochs of maxima do not follow those of the minima at constant intervals, but vary from a little more than three to five years. In spite, however, of these probable sources of error, Prof. Bigelow deduces a circulation not very different from the one mentioned above, so that all the three computations and deductions show that there is a very definite movement in latitude and change in percentage frequency of occurrence from year to year.

A most interesting and important contribution, by Prof. T. H. Davis, to our knowledge of the fluctuation of the annual wind resultants, and indirectly to our knowledge of the movements of cyclones and anticyclones, appeared in one of the recent numbers of the *Monthly Weather Review* (vol. xxx. No. 11, p. 519). The investigation was restricted chiefly to stations included in the meteorological services of the United States and Canada, and the period discussed was the ten years 1891–1900. The results of the research

are best seen by consulting the map accompanying the paper, on which all the mean wind directions for each year and for each station are plotted.

Most interesting curves of wind resultants at Key West, Bermuda, Mt. Washington, and Pike's Peak are reproduced. Prof. Davis concludes by saying:—"The remarkable relations revealed by these tables and charts show that the natural relations of the winds are complex and still obscure. I see no indication of a sun-spot nor of a lunar influence. To what natural laws or combination of laws are we to attribute these variations in the annual resultants?" Perhaps, as a suggestion, Prof. Davis might correlate the variations of the wind directions in the southern stations with the barometric changes from year to year, which latter have recently been shown to be nearly identical with those in South America, and the inverse of those in the regions about the Indian Ocean and Australia.

In connection with the preceding paragraph, the paper by Prof. K. Kassner, on "Sonnenflecken, Depressionen der Zugstrasse V^b und Niederschläge". (*Annalen der Hydrographie und Maritimen Météorologie*, March) is of great interest. The author has analysed the variations in the yearly number of barometric minima which pass along this cyclone track, as specified by van Bebber, for the long period 1874 to 1901. He shows that the variations are in general agreement with an inverted sun-spot curve, that is, that there is a greater number of these low pressure areas at sun-spot minima than at the maxima. There are, however, several outstanding minor variations of shorter period.

A CAMERA FOR NATURALISTS.

We have recently had an opportunity of inspecting one of the "Birdland" cameras made by Messrs. Sanders and Crowhurst, of 71 Shaftesbury Avenue, to the design of Mr. Oliver G. Pike. Mr. Pike is well known as a specialist in the photography of birds and all that pertains to them, and so far as we, who are not specialists in this matter, are able to judge, the camera that he has designed is excellently adapted for the use of naturalists. Certainly no pains have been spared on the part of the makers to carry out Mr. Pike's ideas in a serviceable and practical way. The lens is a Goerz double anastigmat of 7 inches focal length, and by opening the front of the camera and drawing the lens forward, a change that is effected in a few seconds, the back combination may be used alone.

The range of focusing is sufficient to photograph objects within four or five feet even when the single combination is used, and the power that this provides in conjunction with the lens of twelve or thirteen inches focal length in getting large images will be appreciated by anyone who has attempted the photography of small animals. Focusing scales are affixed both for the complete lens and the single combination, though these would probably be rarely used, as the finder is a reflex arrangement that gives a full-size view of the image that falls upon the plate when the shutter is operated. An important point with regard to the finder is that its image can be seen when viewed from above, as usual, and also by looking horizontally when the camera is level with the eye. A mirror in the hood effects this desirable convenience. The shutter is the focal plane Anschutz, but with a device made specially by Messrs. Sanders and Crowhurst for linking it with the mirror within the camera that reflects the image upwards on to the finder screen. One release removes the mirror and operates the shutter, all the movements taking place smoothly and practically noiselessly. The camera is covered with a dull green leather, and all metal parts are bronzed, so that it forms an inconspicuous object in the ordinary surroundings of the country.

ENTOMOLOGY AT THE CAPE.[1]

The Cape has been described as the most magnificent natural museum of insect pests and parasitic diseases which the world possesses, and the report of Mr. Lounsbery for 1901 shows that, despite the dislocation induced by the war, he is making good use of his opportunities. The various reports show clearly the directions economic entomology is now taking—the introduction of parasitic species which prey upon the pests, particularly of ladybirds feeding upon aphis and scale—fumigation of infested plants with hydrocyanic acid or carbon bisulphide—and the compounding of different sorts of spraying mixtures. Mr. Lounsbery gives accounts of several attempts at the introduction of exotic ladybirds from California to keep mealybug, scale and American blight in check, though none of them have yet become established, as has, however, been successfully achieved with the Vedalia, which keeps *Icerya purchasi* in check. Various recipes for making paraffin emulsions are given; considering the efficacy of paraffin as an insecticide, and the difficulty that is always experienced in keeping it emulsified, it is strange that more trial is not made of the method devised by Mr. H. H. Cousins of increasing the specific gravity of the paraffin by dissolving naphthalene in it. Another section of economic entomology treated in this report is the investigation of a cattle tick which serves as an intermediary host for a parasite causing "heart water," a disease mainly affecting sheep and goats, and of another tick-propagated disease known as malignant jaundice of dogs.

One interesting application of modern methods which may be found here reported is the fumigation with hydrocyanic acid of gaols, asylums, and kindred public buildings to free them of the insect vermin which are so terribly abundant in South Africa.

[1] Cape of Good Hope Report of the Government Entomologist for 1901. Pp. 103. (Cape Town, 1902.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Mr. A. C. Seward, F.R.S., has been reappointed University lecturer in botany. The University lectureship in midwifery is vacant by the resignation of Mr. Stabb. Candidates are to make application to the Vice-Chancellor before October 20. Mr. L. Doncaster, King's, has been appointed assistant to the superintendent of the museum of zoology.

The University College of South Wales and Monmouthshire, Cardiff, is proposed for adoption as an institution affiliated to the University of Cambridge.

Dr. Humphry, Dr. S. West, and Dr. W. Hale White have been appointed examiners in medicine; Dr. Herman and Dr. Handfield Jones examiners in midwifery; and Mr. Clinton Dent, Mr. E. Ward, and Mr. E. Owen examiners in surgery—for the third M.B. examination. Mr. F. C. Parsons, St. Thomas's Hospital, London, has been appointed an examiner in human anatomy. Mr. A. E. Shipley has been reappointed University member of the council of the Marine Biological Association.

A chair of agricultural botany has been established at the University of Rennes, and M. Daniel has been elected the first professor.

The late Alderman Benjamin Robinson, chemical manufacturer, bequeathed 500*l.* for scholarships in connection with the Royal Salford Technical Institute.

Dr. J. J. R. Macleod, assistant demonstrator of physiology at the London Hospital, has been appointed professor of physiology at the Western Reserve University, Cleveland, Ohio.

Dr. John Ryan has been appointed principal of the Paddington Technical Institute of the London County Council. Dr. Ryan was formerly professor of engineering at University College, Nottingham, and at University College, Bristol, and has for the past three years held the post of principal of the Woolwich Polytechnic.

The Edinburgh summer meeting, which was instituted in 1886 and held annually until 1899, is now to be resumed, and the course will extend from August 3 to 29. The meeting will be directed by Prof. Patrick Geddes, and will deal this year especially with a study of Edinburgh and its region. The requirements of Scottish and English teachers in nature-study will receive prominent attention, and a series of excursions to various places of interest will be held. Sir John Murray, Prof. J. Arthur Thomson, and

Mr. J. G. Goodchild are assisting in various departments. Communications should be addressed to the secretary at the Outlook Tower, Edinburgh.

A SUMMER meeting of university extension students will be held in Oxford in August, the first part being from August 1 to August 13, and the second from August 13 to August 24. The inaugural address will be delivered on Saturday, August 1, at 8.30 p.m., by the United States Ambassador. The programme of lectures is grouped in five sections, one of which is natural science. The list of lecturers includes the names of Dr. C. W. Kimmins, Mr. Michael Sadler, and Prof. Sims Woodhead. Conferences have been arranged on "The Education Act of 1902 and University Extension," chairman, Sir William Anson, M.P.; "Free Libraries and Popular Education," chairman, Lord Goschen, F.R.S.; and "Science in its Relation to Industry," chairman, Sir Philip Magnus.

THE President of the Board of Education has appointed Dr. H. F. Heath, Academic Registrar of the University of London, to the post of director of special inquiries and reports rendered vacant by Mr. Sadler's resignation on May 9. As the papers describing the circumstances which led Mr. Sadler to resign an office filled by him with such success since 1895, when it was created, have not yet been laid before Parliament, the appointment of a new director was unexpected, and will be received with surprise by the educational world. For eight years Mr. Sadler has been engaged in collecting materials for the study of educational systems and methods, and the information he has rendered available in his eleven volumes of special reports has been of the greatest assistance to students of educational science. But scientific method and thoroughness meet with little encouragement in this country, and though everyone seriously interested in education recognises the value of Mr. Sadler's work and understands its formative influence, it is evident that to the official mind the exigencies of the moment are of more consequence than scientific knowledge. It is to be hoped that the outcome of the affair will be to place the Special Inquiries Office on a firmer footing, and that the new director will be given increased facilities for the continued efficiency of the work carried on by Mr. Sadler.

THE programme of summer rambles for the present season, published in connection with the biology section of the Essex County Education Committee, and prepared by Mr. E. C. Horrell with the assistance of Mr. F. J. Chittenden, should prove very useful to teachers of nature-study. It is noteworthy that two distinct rambles in different parts of the county are arranged for each Saturday afternoon during June and July, so that a large number of teachers is given the opportunity of attending. Each ramble is conducted by a member of the biological staff. The excursions are intended to afford opportunities to teachers to gain experience in the methods adopted in the study of nature in the field. Any teacher is eligible who takes an interest in general natural history, and is prepared to devote a little leisure to its study. There is no fee, but teachers bear their own expenses. The advice given to intending ramblers is sensible and practical, as the following quotations show:—"Students must not needlessly uproot plants, tread upon crops, break through fences, or leave gates open." "The teacher should always bear in mind that most biological and morphological facts can be illustrated quite as satisfactorily by a common plant as by a rare one, and a plant should never be collected simply because it is rare." It would be difficult to devise a better plan to secure rational nature-study work in our schools than this way of first educating the teachers to become intelligent observers.

IN a letter to the *Times* of June 8, Mr. Sidney Lee draws an interesting and instructive comparison between American and British methods of appointing university professors. Of the superiority of the American plan there can be no doubt. In America, as soon as a vacancy arises in the professorial staff, the president of the university consults members of the faculty concerned. He invites their opinion as to who is the fittest man to fill the vacant chair. But the president does not confine his inquiries to his immediate circle of colleagues. Knowledge of the reputations that men are acquiring in academic work is wonderfully well diffused. The president who is seeking to fill a vacant chair has at command ready means of communication with presidents and professors of other universities. After due and thorough investigation, he forms his decision as to how the vacant post may be filled with greatest advantage to the institution over which he presides. He then forwards an invitation to the chosen person to occupy the vacant office. The procedure in vogue in this country is too well known to require description, and the only argument Mr. Lee has found in its favour is that it enlarges the electors' field of choice. "But," he remarks, "this argument is open to most serious question. Men of ordinary sensitiveness often refuse to submit themselves to the humiliating ordeal of public or semi-public competition for a vacant professorship, which in many respects reduces them to the level of advertising vendors of quack medicines. In effect the prevailing system often narrows the field of choice open to the electors, who are not in the habit of looking outside the panel of self-appointed candidates; it is, indeed, doubtful if honourable regard for the terms of their public advertisements permit them such a course of action."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 30.—"Preliminary Note on the Use of Chloroform in the Preparation of Vaccine." By Alan B. **Green**, M.A., M.D. (Cantab). Communicated by W. H. Power, M.D., F.R.S.

Briefly stated, the method of preparing vaccine by the chloroform process is described as follows:—Vaccine emulsion is first prepared by triturating one part by weight of vaccine pulp with three parts by weight of water. Through this emulsion, air charged with chloroform vapour is passed, with the result that the water of the emulsion becomes saturated with chloroform (1 in 200). After such saturation all excess of chloroform immediately escapes automatically from the vaccine, and the lymph is not brought into contact with a stronger solution of chloroform than 1 in 200. The extraneous micro-organisms originally present in the lymph are by this means killed in from one to six hours, while the lymph remains fully potent for vaccination. Vaccinations have been performed with lymph prepared in this way with highly successful results.

By the chloroform process, lymph, free from extraneous micro-organisms, can be distributed for use twenty-four hours after collection from the calf, instead of after the lapse of a month or longer, which is the time generally necessary for the elimination of these organisms by the glycerine process. The rapid preparation of lymph by the chloroform process possesses many obvious advantages.

Zoological Society, May 12.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—Mr. W. B. **Tegetmeier** exhibited a skin and some illustrations of a species of pheasant from Mongolia recently described under the name of *Phasianus hagenbecki*. He suggested that it would make a handsome addition to our coverts.—Mr. Frank **Finn** spoke on variation in wild mammals and birds, and exhibited illustrative living specimens and drawings. The specimens included a frontlet of the barking-deer (*Cervulus muntjac*), bearing supernumerary antlers springing from the bony pedicles below the ordinary antlers; two abnormally-coloured Sambhar deer (*Cervus unicolor*); a goldfinch (*Carduelis carduelis*), showing red patches at the back of the head; and an albinistic variety of the ruff (*Pavoncella pugnax*), with head and neck nearly white.—Mr. F. E. **Beddard**, F.R.S., exhibited preserved and injected brains of mammals prepared in the Society's prosectorium.—Dr. J. F. **Gemmill** read a contribution to the study of double monstrosities in fishes. It contained an account of the anatomy of double monster trout-embryos, reference being made to the fusion, disappearance, or modification of organs which occurred at the region of transition from the double to the normal condition.—Mr. Robert **Gurney** dealt with the metamorphoses of the decapod crustaceans *Ægeon fasciatus*, Risso, and *Æ. trispinosus*, Hailstone. The larvæ of the two species were described, and comparisons made with those of other Crangonidæ, from which it was shown

that the known larvæ of the British Crangonidæ fell naturally into three groups, representing the genera Ægeon (which would include Cheraphilus), Crangon, and Pontophilus.—Mr. C. Tate **Regan** read a paper on the fishes collected by Dr. Goeldi at Rio Janeiro. Four species were described as new.—Mr. Martin **Jacoby** described fifty-six new species of South American Coleoptera of the family Chrysomelidæ.

Geological Society, May 13.—Mr. E. T. Newton, F.R.S., vice-president, in the chair.—On some disturbances in the Chalk near Royston (Hertfordshire), by Mr. H. B. **Woodward,** F.R.S. The disturbed Chalk near Royston, with its fractured and displaced flints, occurs in conjunction with Boulder-clay, and the latter is found beneath a considerable thickness of disturbed Chalk. While Boulder-clay occurs along the high ground bounding the disturbed area to the south, the undulating downs to the north are devoid of this Glacial Drift. The facts were to be explained, on the land-ice theory, if the ice were at first welded to the rubbly surface-strata in regions north of the escarpment, and, when movement set in, there were overthrusts of débris-laden ice, and upper layers of ice were rent asunder from and moved over lower ones; while to the thrust or long-continued pressure of ice along shear-planes at the higher levels may be attributed the belt of disturbed strata.—On a section at Cowley, near Cheltenham, and its bearing upon the interpretation of the Bajocian denudation, by Mr. L. **Richardson.**—Description of a species of Heterastræa from the Lower Rhætic of Gloucestershire, by Mr. R. F. **Tomes.** The specimen was obtained from Lower Rhætic Beds at Deerhurst (Gloucester). It occurred a little above the bone-bed; it is specifically new and generically new to the Rhætic, and it displays Jurassic relationships. It differs from the several Liassic species in the small size of the corallum and of its calices.

Royal Meteorological Society, May 20.—Captain D Wilson-Barker, president, in the chair.—Mr. C. P. **Hooker** read a paper on the relation of the rainfall to the depth of water in a well. In this he gave the weekly measurements of the depth of water in a well (101 feet deep) and the amount of rainfall at Cirencester, extending over the sixteen years 1887–1902. The depth of water in the well depends on how much rain penetrates, and the penetration is determined by the amount of rain, the rapidity of its fall, and the existing condition of the soil. The winter rains penetrate easily, and the summer rains with difficulty. Mere absence of rain is not the only cause of scarcity, deficiency of spring rains, and subsequent heat and evaporation being far more important factors. After the early spring months but little rain penetrates to the well, so that a timely forewarning at that season might prove of great value by enabling the existing supplies to be husbanded at an early period. Considering how narrow is the boundary between sufficiency and want, and looking to the fact that every year sees further demands made on our water supplies, the author considers that it is of the utmost importance that more attention should be paid to the storage of our surplus winter rains. This might be done by the formation of large hill reservoirs, and doubtless such measures as the reafforesting of large tracts of land would be of use in checking the rapidity with which the rains reach the rivers and are so lost.—Mr. W. **Marriott** gave an account of the frost of April, which was so keenly felt coming after the long spell of very mild weather in February and March. The fortnight April 12–25 was marked by keen northerly winds, great dryness, and low temperatures. Frosts on the ground were of almost nightly occurrence, and as the result, the destruction of the fruit blossom has been very great and also very general. In many places a good deal of the apple and strawberry blossom, although only in bud at the time, was killed, while potatoes were cut to the ground, and the foliage of horse chestnuts and limes much injured, particularly on the windward side.

Royal Microscopical Society, May 20.—Dr. Hy. Woodward, F.R.S., in the chair.—Mr. C. L. **Curties** exhibited a new monochromatic light apparatus, which was a modification of that shown at the November meeting by Dr. Spitta. It consisted of an optical bench carrying a Nernst electric lamp, aplanatic bulls-eye condenser, adjustable slit, achromatic collimating lens, a prism upon which was mounted a Thorpe replica grating, and an achromatic projection lens, the whole being fitted upon a mahogany base capable of being tilted. The spectrum given was exceedingly brilliant, and any part could be brought into the field of the microscope.—Messrs. W. **Watson** and Sons exhibited a new form of museum microscope placed inside a locked glass case through which the eye-piece projected. There was a circular disc in place of the ordinary stage, upon which twelve slides could be fixed; it was rotated from the outside, so as to bring each object into the field. Messrs. Watson also exhibited a bulls-eye condenser of long focus for photomicrographic purposes, fitted with iris diaphragm and centring adjustments.—There was an exhibition of pond life by fellows of the Society and members of the Quekett Microscopical Club.—It was announced that at the next meeting on June 17 there would be a communication from Lord Rayleigh on Mr. Gordon's paper on the Helmholtz theory of the microscope, and that Dr. H. Siedentopf would give a demonstration of his method of making visible ultra-microscopic particles in glass, and the application of the method to bacteria.

CAMBRIDGE.

Philosophical Society, May 4.—Dr. Baker, president, in the chair.—On Mendelian heredity of three characters allelomorphic to each other, by Mr. W. **Bateson,** F.R.S. The object of this note was to direct attention to various possibilities attainable by a modification of the Mendelian method. In the ordinary method the constitution of the gametes in the first cross (F_1) is tested by breeding such individuals *inter se* or with a pure recessive. The ensuing generation (F_2) will consist of a mixture of dominant and recessive individuals; but if the proportions depart from the expected 3 : 1 or 1 : 1, it is not possible to tell whether such departure is due to change in relative numbers of dominant and recessive gametes, to imperfect segregation of characters, or to change in dominance. This question can in part be answered by a method which consists in crossing F_1 produced from a parent having one dominant character with another heterozygous individual having a different dominant character (the same recessive being used in both cases).—On the diathermancy of antimonite, by Mr. A. **Hutchinson.**—On the potential difference between the terminals of a vacuum tube, by Mr. W. A. D. **Rudge.** The experiments described in the paper were made in a tube which contained a perforated and movable metal disc. It was found that the presence of the disc caused the potential difference between the ends of the tube to rise considerably above that of a perfectly similar tube without a disc. The increase varied with the nature of the metal; using different metals as discs, the order of increase was Pb 1, Ag 1·25, (Cu Fe Zn) 1·35, Al 3·5, Mg 3·8.—The determination of curves satisfying given conditions, by Mr. H. **Bateman.**—On the existence of a radio-active gas in the Cambridge tap-water, by Prof. **Thomson,** F.R.S. (see p. 90).—On a continuous spectrum, by Mr. T. H. **Havelock.**—On the Thomson effect in alloys of bismuth and tin, by Mr. S. C. **Laws.** The quantity of heat evolved or absorbed in consequence of the temperature gradient when a current C passes between two sections of a homogeneous conductor the difference of temperature of which is δT may be represented by $C\sigma\delta T$. These experiments comprise some measurements of the quantity σ—the specific heat of electricity—in bismuth and alloys of bismuth and tin. Some values for σ obtained in this way are:—bismuth 860 ergs per absolute unit current per 1° C.; alloy containing 1·3 per cent. tin 10,700 ergs per absolute unit current per 1° C.; alloy containing 6 per cent. tin 11,200 ergs per absolute unit current per 1° C.—A preliminary account of an investigation of the effect of temperature on the ionisation of gases acted on by Röntgen rays, by Mr. R. K. **McClung.** This paper gives some of the results obtained in a series of experiments made to ascertain what effect the heating of a gas has on the amount of ionisation produced in it by the action of Röntgen rays. The results obtained show conclusively that the amount of ionisation is independent of the temperature of the gas when the density of the gas is kept constant. Observations were made on air for a range of temperatures of nearly two hundred degrees from about 9° C. to a little more than 200° C. Carbon dioxide was also examined for a slightly wider range of temperatures, and precisely the same result was obtained as for air.

EDINBURGH.

Royal Society, May 5.—Prof. Geikie in the chair.—Mr. J. G. **Goodchild** read a paper dealing with (1) Scottish cairngorms, amethysts, and quartz, (2) chalcedony, opal and jasper, in which many interesting details were given of the valuable collection in the Museum of Science and Art. Important questions as to the genesis of these minerals and the influence of environment were indicated as calling for careful investigation.—Mr. J. G. **Goodchild** also read a paper on the phonetics of Gaelic, a subject to which he had devoted attention for many years. A specimen of Gaelic, which Prof. Mackinnon had put together as containing all the different sounds used in Gaelic, was transliterated in the phonetic alphabet known as palæotype, and each sound was then discussed, especially in relation to its mode of production. The author argued that many of the peculiarities of Gaelic sounds were due to the resonance in the vestibule or chamber immediately above the glottis.—Dr. A. T. **Masterman** gave a brief note on the heart and pericardium in Enteropneusta, Echinodermata and their allies, sketching what he believed to be the process of embryological development. One stage he had not, however, been able as yet to observe.—Prof. C. G. **Knott** communicated a further instalment of his investigations into the interrelations of the resistance and magnetisation of nickel at high temperatures. In the later experiments the temperature was pushed up to about 400° C. The increase of resistance of a particular wire when magnetised was found to increase as the temperature was raised, but afterwards greatly to decrease. This was to be expected if we suppose that the greatness of this effect in the magnetic metals is due to their magnetisation. At the highest temperature reached the percentage change of resistance in a moderate field was about one-sixtieth of the value at ordinary temperatures.

May 18.—The Hon. Lord M'Laren in the chair.—Dr. Alex. M. **M'Aldowie** read a paper on the human plantar reflexes. The lower limb in infants was a prehensile limb, and the reflex movement when the sole was tickled was similar to that in monkeys. As the child began to try to walk, the character of the reflex changed, and became ultimately plantigrade in type. The prehensile reflex, however, remained in abeyance, and manifested itself in disease. Under these conditions it appeared as soon as the cerebral control was withdrawn or overcome, and thus permitted the spinal control to reassert itself. It was a remarkable fact that such a reflex, which disappeared so early in the individual life, should reappear under pathological conditions. The author considered that this permanence of the prehensile reflex indicated that the period in the development of the ancestors of the human race when the lower limb was an organ of prehension was one of immense duration.—Sir William **Turner**, K.C.B., in a paper on the occurrence of the sperm whale or cachalot in the Shetland seas, described in detail the lower jaw, the teeth, and the tympano-petrous bones of a large specimen which had been found dead near Hillswick, Shetland, in August, 1901. The animal was a male, and was 61 feet long. The point of a massive explosive harpoon was found imbedded in the head, and had penetrated the great chamber for the lodgment of the spermaceti, most of which had consequently drained away. Of the sixty-four teeth obtained, forty-two were mandibular, seven were doubtful, probably mandibular, but had never cut the gum, and the remaining fifteen belonged to the upper jaw. They were of various shapes, straight and curved, and were obviously rudimentary and functionless. The paper contained a history of other occurrences of sperm whales in the Shetland seas, and closed with a comparative study of the tympano-petrous bones of Physeter, Kogia, and other Odontoceti.—In a preliminary note on the shedding of scales in gadoid fishes, Mr. Alex. Wallace **Brown** brought evidence in favour of the view that these fish shed their scales before spawning, and that this shedding ceases when the fish cease spawning. Should this fact be established by future investigation, the ordinary view that the rings on the scales indicate years of growth will have to be abandoned.

PARIS.

Academy of Sciences, June 2.—M. Albert Gaudry in the chair.—On certain singularities of partial differential equations of the elliptic type, by M. Émile **Picard**.—On some new fossils from the Soudan, by M. A. **de Lapparent**. Further fossils found by Captain Gaden in the Soudan are undoubtedly Cretaceous in type. One of them, an ammonite, is related to the genus Mammites and also to Vascoceras. The sea must thus have extended as far as Tchad, and covered the Damerghou. It is nearly certain that during the Cretacean epoch it joined the Atlantic, and that the whole of Africa north of 13°–14° N. latitude was occupied by a vast sea, from which the high lands of Abyssinia and an island including Aïr, Tassali, Ahaggar and Tademaït emerged.—Astronomical and magnetic work at Madagascar, by M. P. **Colin**. A series of measurements of the magnetic elements showed a diminution in the declination at Tamarive of 11′ between May, 1902, and April, 1903, with a slight maximum in September; the inclination diminished 1′ 45″, and the horizontal component diminished by 0·00033.—On the infinitesimal properties of linear systems of circles, by M. **Mesuret**.—On the anisotropy of silk, and on the value of Poisson's ratio for this substance, by M. F. **Beaulard**. The results of the measurements given show clearly that silk is not isotropic.—On the magnetism of liquids and crystals, by M. Georges **Meslin**. No solid belonging to the cubical system exhibits the phenomenon of magnetic dichroism.—On the heat conductivity of iron in the magnetic field, by M. A. **Lafay**. The experiment of Maggi, which would appear to show that the heat conductivity of iron is affected in a magnetic field, is a convection phenomenon due to the air, and is not observed in a vacuum. There is some experimental ground for supposing that in a very intense magnetic field the conductivity of iron for heat is appreciably diminished, but the effects do not vary with variations in the direction of the magnetic and heat flux.—On the utilisation of energy for transmission in wireless telegraphy, by M. G. **Ferrié**.—On the radiations emitted by radio-active lead, by MM. **Korn** and **Strauss**. On comparing the photographic effect of equal quantities of radio-active lead, in the form of sulphate, one of which had been exposed to the influence of the kathode rays for ten minutes, it was found that the action on the photographic plate was much more intense in the case of the exposed sample. This effect could not be due to phosphorescence, since the photographic action was unaffected by interposing a thin plate of aluminium or black paper. No other radio-active material appears to show this effect, which is remarkable in that there is no corresponding increase in the electro-active power, the rate at which an electrified body is discharged remaining the same.—On the emanation of radium and its coefficient of diffusion in air, by MM. P. **Curie** and J. **Daune**. The view of Rutherford that the emanation of radium behaves as a gas is confirmed by a fresh experimental method. The fact that the emanation of radiation is condensed at the temperature of liquid air, first announced by Rutherford, is also confirmed.—On the purification of hydrogen on the industrial scale by cold, by M. Ch. **Renard**. Crude hydrogen passed at the rate of one to two litres per minute through a vessel containing liquid air is completely freed from hydrogen arsenide. The method may be practically useful in the purification of hydrogen for balloons.—On the cementation of steel, by M. Léon **Guillet**. The velocity of penetration of the steel by the carbon depends upon the temperature, the time, and the nature of the substance supplying the carbon. By simple cementation certain nickel steels acquire the same hardness as carbon steels, when the cementation of the latter has been followed by tempering.—The decarburation of steels and thin metallic plates by evaporation in a vacuum, by M. G. **Belloc**.—On the form assumed by mercuric iodide on separating from solution, by M. D. **Gernez**. When mercuric iodide is formed either by volatilisation or evaporation from solution at low temperatures, the unstable yellow form is produced.—Observations on the precipitation of manganese by persulphuric acid in acid solution, by M. H. **Baubigny**. A study of the effect of varying the volume of the solution in which the precipitation is carried out.—The alloys of copper and magnesium, by M. O. **Boudouard**. In a preceding paper the study of the fusibility curve indicated the existence of three definite combinations: Cu_2Mg, $CuMg$, and $CuMg_2$. In the present paper these results are confirmed by a metallographic study of the alloys.—On the silicides of chromium, by MM. P.

Lebeau and J. **Figueras.** Four silicides have been isolated, corresponding to the compositions $SiCr_3$, $SiCr_2$, Si_2Cr_3 and Si_2Cr. Details of the preparation and properties of Si_2Cr_3 are given.—The electrolytic reduction of unsaturated acids, by M. C. **Marie.** By the use of mercury as a kathode, the unsaturated acids may be reduced to the corresponding saturated acids.—On dibromo-acetylene, CBr : CBr, by M. P. **Lemoult.**—On *Pyronema confluens*, by M. P. H. **Dangeard.**—On the botanical characters of the mycelium of the truffle, by M. Louis **Matruchot.**—The morphological characters of Pleurocecidia, by M. C. **Houard.**—On some fossil algæ in ancient strata, by M. B. **Renault.** As the result of a microscopical examination of boghead cannels the conclusion is drawn that these were formed by the accumulation of gelatinous algæ at the bottoms of lakes, each layer of coal being recognisable by the genus of algæ producing it.—On the present state of the volcano of Mont Pelée, by M. **Giraud.**—On the geology of the neighbourhood of Cinglais (Calvados), by M. A. **Bigot.**—On the graphical characters of fatigue in voluntary movements in man, by MM. A. **Imbert** and J. **Gagnière.**—The degradation of carbohydrates in the animal organism, by MM. A. **Bach** and F. **Battelli.** The theory is put forward that two alternating actions are at work, both produced by enzymes. The carbohydrates are first hydrolysed, with production of carbon dioxide, and then acted upon by an oxidising enzyme, with evolution of water. According to this view the carbon dioxide is never formed by direct oxidation, but by hydrolysis.

DIARY OF SOCIETIES.

THURSDAY, JUNE 11.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—The Bending of Eletric Waves round a Conducting Obstacle; Amended Result: H. M. Macdonald, F.R.S.—On the Propagation of Tremors over the Surface of an Elastic Solid: Prof. H. Lamb, F.R.S.—The Diffusion of Salts in Aqueous Solutions: J. C. Graham.—On the Structure of Gold Leaf, and the Absorption Spectrum of Gold: Prof. J. W. Mallet, F.R.S.—On Reptilian Remains from the Trias of Elgin: G. A. Boulenger, F.R.S.—A Method for the Investigation of Fossils by Serial Sections: Prof. W. J. Sollas, F.R.S.—An Account of the Devonian Fish, *Palaeospondylus Gunni*, Traquair: Prof. W. J. Sollas, F.R.S., and Miss I. B. J. Sollas.—The Measurements of Tissue Fluid in Man; Preliminary Note: Dr. G. Oliver.—Observations on the Physiology of the Cerebral Cortex of the Anthropoid Apes: Dr. A. S. F. Grunbaum and Prof. C. S. Sherrington, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—Quaternions: Major P. A. MacMahon.—Automorphic Functions and the General Theory of Algebraic Curves: Mr. H. W. Richmond.—Jacobi's Construction for Quadric Surfaces: Prof. G. B. Mathews.—Addition to the Papers on Four Known Simple Groups of Order 25920: Prof. L. E. Dickson.

FRIDAY, JUNE 12.

PHYSICAL SOCIETY, at 5.—Some Experiments on Shadows in an Astigmatic Beam of Light: Prof. S. P. Thompson.—The Positive Ionisation produced by Hot Platinum in Air at Low Pressures: O. W. Richardson.—On a Method of Determining the Viscosity of Pitch-like Solids: Prof. F. T. Trouton and E. S Andrews.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Eclipse of the Moon, 1903 April 11: F. W. Henkel.—Note on the Use of Peirce's Criterion for the Rejection of Doubtful Observations: S. A. Saunder.—On a Probable Relationship between the Solar Prominences and Corona: W. J. S. Lockyer.—Note on the Present Condition of the Lunar Theory: E. Nevill.—On the Relation between the Light Changes and Orbital Elements of a Close Binary System; with Special Reference to RR Centauri: A. W. Roberts.—Recent Observations of Mars and Jupiter: W. F. Denning.—The Spectra of Sun-spots in the Region B-D: Rev. A. L. Cortie.—Experiments as to the Actuality of the "Canals" observed on Mars: J. E. Evans and E. W. Maunder.—*Promised Papers*: Positions of 170 Stars around Nova Geminorum, and a Discussion concerning the Difference between two Exposures on the same Plate: F. A. Bellamy.—Examination of Mr. Whittaker's "Undulatory Explanation of Gravity" from the Physical Standpoint: G. Johnstone Stoney.—Observations of the Satellite of Neptune from Photographs taken with the 28-inch Refractor: Royal Observatory, Greenwich.—Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1902, deduced from Photographs taken at the Royal Observatory, at Dehra Dun (India), and in Mauritius: Royal Observatory, Greenwich.

MALACOLOGICAL SOCIETY, at 8.—A List of Species of Mollusca from South Africa, forming an Appendix to G. B. Sowerby's "Marine Shells of South Africa": E. A. Smith.—On a New Genus, Planorbia, Moore, from the Albert Edward and Albert Nyanzas: J. E. S. Moore.—Notes on Some Jurassic Shells from Borneo, including a New Species of Trigonia: R. Bullen Newton.—Description of *Marginella lateritia*, n.sp., from the Andaman Islands: J. C. Melvill and E. R. Sykes.—New Mollusca from New Zealand: Rev. W. H. Webster.

MONDAY, JUNE 15.

VICTORIA INSTITUTE, at 4.30.—Annual Meeting.—Address by Prof. W. M. Flinders Petrie.

TUESDAY, JUNE 16.

ROYAL STATISTICAL SOCIETY, at 5.

ZOOLOGICAL SOCIETY, at 8.30.—On an Extinct Species of Genet (*Genetta plesictoides*) from the Pleistocene of Cyprus: Miss Dorothy M. A. Bate.—Description of a New Fish of the Gobiid Genus Rhiacichthys from British New Guinea: G. A. Boulenger, F.R.S.—Descriptions of New Reptiles from British New Guinea: G. A. Boulenger, F.R.S.—The Marine Fauna of Zanzibar and British East Africa, from Collections made by Mr. Cyril Crossland in the Years 1901 and 1902—Polychæta, Part II.: Cyril Crossland.

INSTITUTION OF CIVIL ENGINEERS, at 9.—"James Forrest" Lecture, Some Unsolved Problems in Engineering: W. H. Maw.

WEDNESDAY, JUNE 17.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On the Theory of Optical Images, with Special Reference to the Microscope: Lord Rayleigh, F.R.S.—On a Method of making Visible Ultra-microscopic Particles in Glass, and the Application of the Method to Bacteria: Dr. H. Siedentopf.—On the Lag in Microscopic Vision: E. M. Nelson.

CHEMICAL SOCIETY, at 5.—(1) The Estimation of Arsenic in Fuel; (2) The Electrolytic Estimation of Minute Quantities of Arsenic, more Especially in Brewing Materials: T. E. Thorpe.—Crystallised Ammonium Sulphate and the Position of Ammonium in the Alkali Series: A. E. H. Tutton.—Action of Hydrogen on Sodium: A. Holt, jun.—(1) The Action of Halogens on Compounds containing the Carbonyl Group; (2) Reactions involving the Addition of Hydrogen Cyanide to Carbon Compounds: A. Lapworth.—The Acetoacetic Ester Synthesis: A. C. O. Hann and A. Lapworth.—Rimu Resin: T. H. Easterfield and B. C. Aston.—Note on the Karaka Fruit: T. H. Easterfield and B. C. Aston.

INSTITUTION OF CIVIL ENGINEERS, at 10 a.m.—Inaugural Address of the Engineering Conference: John Clarke Hawkshaw.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—The Meteorological Aspects of the Storm of February 26–27, 1903: Dr. W. N. Shaw, F.R.S.—The Dines-Baxendell Anemograph and the Dial-pattern Non-oscillating Pressure-plate Anemometer: Joseph Baxendell.

THURSDAY, JUNE 18.

ROYAL SOCIETY, at 4.30.—*Probable papers*: (1) Surface Flow in Crystalline Solids under Mechanical Disturbance: (2) The Effects of Heat and of Solvents on Thin Films of Metal: G. Beilby.—The Magnetic Expansion of some of the Less Magnetic Metals (with an Appendix by G. A. Schott): Dr. P. E. Shaw.—On the Discharge of Electricity from Hot Platinum: Dr. H. A. Wilson.—The Bionomics of *Convoluta Roscoffensis*, with Special Reference to its Green Cells: Dr. F. W. Gamble and F. Keeble.—New Investigations into the Reduction Phenomena of Animals and Plants: Preliminary Communication: Prof. J. B. Farmer, F.R.S., and J. E. S. Moore.—The Action of Choline, Neurine, Muscarine and Betaine upon Isolated Nerve (and upon the Excised Heart): Dr. A. D. Waller, F.R.S., and S. C. M. Sowton.—The Physiological Action of Betain Extracted from Raw Beet Sugar: Dr. A. D. Waller, F.R.S., and Dr. R. H. Aders Plimmer.—On the Physiological Action of the Poison of the Hydrophidæ; Part II. Action on the Circulatory, Respiratory and Nervous Systems: Dr. L. Rogers.—A Paper on the Spectra of Neon, Krypton and Xenon: E. C. C. Baly.—A Study of the Interaction of Mercury and Nitric Acid: Prof. P. Chandra Rây.—And other Papers.

LINNEAN SOCIETY, at 8.—Descriptions of New Chinese Plants: S. T. Dunn.—On the Life-history of a New Indian Species of Monophlebus: E. P. Stebbing.—On the Anatomy of Leaves of British Grasses: L. Lewton-Brain.—Scottish Freshwater Plankton.

FRIDAY, JUNE 19.

ROYAL INSTITUTION, at 9.—Radium: Prof. Pierre Curie (in French).

CONTENTS.

THURSDAY, JUNE 18, 1903.

A SCHEME OF VITAL FACULTY.

Human Personality and its Survival of Bodily Death. By Frederic W. H. Myers. In two volumes. Vol. i. pp. xlvi+700; vol. ii. pp. xx +660, including elaborate index. (London: Longmans, Green and Co., 1903.) Price 2*l.* 2*s.* net.

IN introducing this book to what must be regarded for the most part as a hostile audience, I would claim for it that it is a record of the life-work of a pertinacious and industrious student, in a region beyond the borderland of present orthodox science; and would explain that it has for its object the better comprehension and coordination of a multitude of human faculties, some of them recognised as real though obscure, others not yet generally recognised as existing. The phenomena of sleep, of genius, of multiple personality, of hysteria, of hypnotism, of hyperæsthesia, and of trance, are among those generally recognised by medical specialists and practically treated; though, in truth, most of them seem to be regarded chiefly or solely as pathological curiosities. The phenomena of sensory and motor automatism, of telepathy, and of clairvoyance, are not among the human faculties yet generally recognised. By long study Myers was able to accept them all, in various degrees, and he discerned a thread of connection running through them, so that he felt it possible gradually to design a comprehensive scheme which should include them all,—a building, as it were, in the composition of which each constituent filled its appointed place, so that no part was left forlorn and unsupported by adjacent materials, and so that the eye of science subsequently glancing over it might be willing to recognise the possibility and appropriateness of structures which when isolated had seemed strange and fantastic and incredible.

The construction of such a unified scheme, welding together phenomena often spoken of as occult with others which, though recognised by science, were difficult of interpretation and classification,—like genius, for instance, or hysteria in its many aspects,—was Myers's end and aim; and the result is embodied in two closely-printed volumes. Whether he has succeeded, it is for posterity and for psychologists to say. His treatment is not likely at once to commend itself to philosophers, and it is not as a philosopher that he writes; his treatment aims at being scientific, but it is unusual in being very distinctly literary in form. I shall not argue the matter, but shall content myself with giving such few extracts from the earlier portion of the book as may legitimately present to a critical audience the object and motive power of the whole treatise, a treatise on human personality and vital faculty, which, whether successful or not, is, at all events, more comprehensive and more ambitious than anything which has hitherto been attempted by man in that direction.

If the objection is made that Myers was not a man of science, he himself would have admitted it at once; but I am not so ready to admit it for him. Without the technical training, he seemed to me definitely to have many of the faculties and instincts and powers of a man of science, combined with such a mental grasp, vivid imagination, and power of expression, as would put most of us to shame.

However that may be, I would point out that men not professionally scientific have had a profound influence on scientific progress before now, and if I were to seek for an analogy to the effect which I expect these volumes will have upon the development of the psychical sciences, I would liken it by anticipation to the effect of the "Novum Organon" upon the physical sciences. Francis Bacon was a man of letters, not a scientific man, but he recalled all educated men to the possibility of exploration by experiment and observation, and so cleared the ground and paved the way for the general acceptance of the results of Gilbert and other great and truly scientific men of the same and subsequent eras, whose pioneering work might else have been lost in a mist of dislike, disbelief, and obscurantism.

Myers has shown that obscure psychical phenomena can be legitimately investigated by observation and experiment, and can be regarded as part of a sufficiently comprehensive scheme of natural knowledge; him, then, I liken to Bacon. If we ask who corresponds to the Gilbert of the same age in the psychical sciences, few of us would have any hesitation in bringing forward such names as those of Wallace and of Crookes.

In so far as it may be said that Bacon did not wholly appreciate the work of Gilbert, so we may say something similar of Myers's attitude to what he was constrained to consider the somewhat too trusting disposition of that eminent man Dr. Wallace; though of the more stringent methods and results of Sir W. Crookes he was keenly appreciative.

I am merely stating facts without comment, and will now content myself with a few explanatory and helpful extracts, showing Myers's recognition to the full of the importance of strictly scientific procedure, his appreciation of the stringency and value of scientific proof, and of the difficulties attending scientific investigation in so unknown and comparatively unexplored a territory as that of the psychical nature and spiritual faculties of man.

"The method which our race has found most effective in acquiring knowledge is by this time familiar to all men. It is the method of modern Science—that process which consists in an interrogation of Nature entirely dispassionate, patient, systematic; such careful experiment and cumulative record as can often elicit from her slightest indications her deepest truths. That method is now dominant throughout the civilised world; and although in many directions experiments may be difficult and dubious, facts rare and elusive, Science works slowly on and bides her time—refusing to fall back upon tradition or to launch into speculation, merely because strait is the gate which leads to valid discovery, indisputable truth. . . .

"It is my object in the present work—as it has from the first been the object of the Society for Psychical Research, on whose behalf most of the evidence here set forth has been collected—to do what can be done to break down that artificial wall of demarcation which has thus far excluded from scientific treatment precisely the problems which stand in most need of all the aids to discovery which such treatment can afford.

"Yet let me first explain that by the word 'scien-

tific' I signify an authority to which I submit myself—not a standard which I claim to attain. Any science of which I can here speak as possible must be a *nascent* science—not such as one of those vast systems of connected knowledge which thousands of experts now steadily push forward in laboratories in every land—but such as each one of those great sciences was in its dim and poor beginning, when a few monks groped among the properties of 'the noble metals,' or a few Chaldean shepherds outwatched the setting stars."

As an illustration of the temper of mind which Myers brings to bear, and conceives ought always to be brought to bear, to the understanding of obscure phenomena, I will take the case of witchcraft, and quote as follows:—

"The lesson which witchcraft teaches with regard to the validity of human testimony is the more remarkable because it was so long and so completely misunderstood. The belief in witches long passed—as well it might—as the culminant example of human ignorance and folly; and in so comparatively recent a book as Mr. Lecky's 'History of Rationalism,' the sudden decline of this popular conviction, without argument or disapproval, is used to illustrate the irresistible melting away of error and falsity in the 'intellectual climate' of a wiser age. Since about 1880, however, when French experiments especially had afforded conspicuous examples of what a hysterical woman could come to believe under suggestion from others or from herself, it has begun to be felt that the phenomena of witchcraft were very much what the phenomena of the Saltpêtrière would seem to be to the patients themselves, if left alone in the hospital without a medical staff. And in 'Phantasms of the Living,' Edmund Gurney, after subjecting the literature of witchcraft to a more careful analysis than anyone till then had thought it worth while to apply, was able to show that practically all recorded first-hand depositions (made apart from torture) in the long story of witchcraft may quite possibly have been *true*, to the best belief of the deponents; true, that is to say, as representing the conviction of sane (though often hysterical) persons, who merely made the almost inevitable mistake of confusing self-suggested hallucinations with waking fact. Nay, even the insensible spots on the witches were no doubt really anæsthetic—involved a first discovery of a now familiar clinical symptom—the *zones analgésiques* of the patients of Pitres or Charcot. Witchcraft, in fact, was a gigantic, a cruel psychological and pathological experiment conducted by inquisitors upon hysteria; but it was conducted in the dark, and when the barbarous explanation dropped out of credence much of possible discovery was submerged as well."

Myers's attitude to the in some quarters prevalent creed called spiritualism has been frequently misunderstood, but it is illustrated by the following extract:—

"A large group of persons have founded upon these and similar facts a scheme of belief known as Modern Spiritualism, or Spiritism. Later chapters in this book will show how much I owe to certain observations made by members of this group—how often my own conclusions concur with conclusions at which they have previously arrived. And yet this work of mine is in large measure a critical attack upon the main Spiritist position, as held, say, by Mr. A. R. Wallace, its most eminent living supporter—the belief, namely, that all or almost all supernormal phenomena are due to the action of the spirits of the dead. By far the larger proportion, as I hold, are due to the action of the still embodied spirit of the agent or percipient himself. Apart from speculative differences, moreover, I altogether dissent from the conversion into a sectarian creed of what I hold should be a branch of scientific inquiry, growing naturally out of our existing knowledge. It is, I believe, largely to this temper of uncritical acceptance, degenerating often into blind credulity, that we must refer the lack of progress in Spiritualistic literature, and the encouragement which has often been bestowed upon manifest fraud—so often, indeed, as to create among scientific men a strong indisposition to the study of phenomena recorded or advocated in a tone so alien from Science."

He then relates the rise of a society for investigating psychical matters in a new fashion, among eminent men at Cambridge, who felt that the time was ripe for an attack on superstition and on world-old legendary tradition concerning an unseen world and occult influences—the subject-matter, in fact, of all religion—by purely scientific terrestrial methods, and in the conviction

"that no adequate attempt had yet been made even to determine whether anything could be learnt as to an unseen world or no; for that if anything were knowable about such a world in such fashion that Science could adopt and maintain that knowledge, it must be discovered by no analysis of tradition, and by no manipulation of metaphysics, but simply by experiment and observation—simply by the application to phenomena within us and around us of precisely the same methods of deliberate, dispassionate, exact inquiry which have built up our actual knowledge of the world which we can touch and see. I can hardly even now guess to how many of my readers this will seem a truism, and to how many a paradox. Truism or paradox, such a thought suggested a kind of effort, which, so far as we could discover, had never yet been made. For what seemed needful was an inquiry of quite other scope than the mere analysis of historical documents, or of the *origines* of any alleged revelation in the past. It must be an inquiry resting primarily, as all scientific inquiries in the stricter sense now must rest, upon objective facts actually observable, upon experiments which we can repeat to-day, and which we may hope to carry further to-morrow. It must be an inquiry based, to use an old term, on the uniformitarian hypothesis; on the presumption, that is to say, that if a spiritual world exists, and if that world has at any epoch been manifest or even discoverable, then it ought to be manifest or discoverable now."

As to the objection frequently urged against psychical investigation, on the ground of the asserted triviality and apparent worthlessness of some of the faculties which are the object of study, Myers says:—

"In investigating those faculties we have been in no wise deterred by the fact of the apparent uselessness of some of them for our waking ends. *Useless* is a pre-scientific, even an anti-scientific term, which has perhaps proved a greater stumbling-block to research in psychology than in any other science. In science the *use* of phenomena is to prove laws, and the more bizarre and trivial the phenomena, the greater the chance of their directing us to some law which has been overlooked till now."

Before embarking on his long and laborious quest—the enumeration and dissection of instances and the finding of a hypothesis that should fit and weld them all together—he concludes this part of his introduction with the following modest claim:—

"The truest success of this book will lie in its rapid supersession by a better. For this will show that

least I have not erred in supposing that a serious treatise on these topics is nothing else than the inevitable complement and conclusion of the slow process by which man has brought under the domain of science every group of attainable phenomena in turn—every group save this."

In the belief that this book marks an epoch in the history of psychical science, and that it will ultimately react with beneficial effect on the progress and enlargement of the scope of science generally, I venture to introduce this life-work of my friend to the readers of NATURE, or at least to such of them as are not already familiar with the subject.

OLIVER LODGE.

SCHOOL GEOMETRY REFORM.

A School Geometry. Parts i. and ii. By H. S. Hall, M.A., and F. H. Stevens, M.A. Pp. x + 140. (London: Macmillan and Co., Ltd., 1903.) Price 1s. 6d.

Experimental and Theoretical Course of Geometry. By A. T. Warren, M.A. Pp. viii+248. (Oxford: the Clarendon Press, 1903.) Price 2s.

Elementary Geometry. By Frank R. Barrell, M.A., B.Sc. Section i., part i., pp. xi +116. Price 1s. Section i., part ii., pp. vii+117 to 168. Price 1s. (London: Longmans, Green and Co., 1903.)

Solid Geometry. By Dr. Franz Hocevar. Translated and Adapted by C. Godfrey, M.A., and E. A. Price, B.A. Pp. vii + 80. (London: Adam and Charles Black, 1903.)

A PERSON may be a Cambridge Wrangler, and yet unable to make a simple graphical construction with accuracy. The ordinary schoolboy's knowledge of practical geometry is generally worthless or nil, and his knowledge of pure geometry, the result of his premature encounter with Euclid, is of like character.

But this state of affairs is being rapidly changed. As Messrs. Hall and Stevens say in the first volume of their new geometry, "The working of examples should be made as important a part of a lesson in geometry as it is so considered in arithmetic and algebra."

The book contains an excellent collection of easy graphical and deductive exercises, many of the examples requiring numerical answers. The latter are given at the end. A boy working through this course should acquire a working knowledge of geometry, and a fair insight into the methods of deductive logic.

The volume contains the substance of Euclid book i., and is based on the recommendations of the Mathematical Association; the sequence of Euclid is in the main adhered to. There are two parts, the latter dealing with areas. In this the experimental course is incorporated with the deductive exercises, and assigned equal importance with the latter. This is a good feature, and is to be continued in a further volume which the authors have in preparation. In the present case, it seems to be a defect that the plan has not been carried out to the same, or even a greater, extent in part i., which is concerned with lines, angles, and rectilineal figures. Here it would appear to be especially necessary to make the experimental course predominate. But the subject of school geometry is in a state of transition, and the authors have probably thought it well to proceed cautiously.

Mr. Warren's volume is also based on the report of the Committee of the Mathematical Association. The course includes the fundamental properties of the triangle and circle. Ratio and proportion, similar figures, and polygons are likewise considered. The experimental treatment occupies the first half of the book, and in the second half the same ground is covered, the propositions being formally established by deduction.

The two volumes by Mr. Barrell comprise the first of three sections of a new school geometry which, when complete, will extend to Euclid xi. and the mensuration of the simple geometrical solids. It is written in accordance with the new syllabus of the Cambridge Local Examinations, and the report of the Mathematical Association. Part i. is intended to take the place of Euclid, book i. Part ii. corresponds with Euclid, book iii., 1–34, and also includes a portion of book iv. In the treatment adopted, the experimental and practical course is worked in along with the deductive geometry, and is always made subordinate to the latter. We should like to see the demonstrative geometry relatively less prominent. A feature to be noticed is that the author gives three meanings of a plane angle, in the last of which the angle is regarded as the plane space swept out by a line of indefinite length (one way) turning about one end; the amount of turning is not the angle, but the measure of its magnitude. The author is right in stating that this conception is implied in many of Euclid's phrases. The numerical answers of lengths and areas are given to three significant figures, and of angles to the nearest ten minutes. In the latter case decimals of a degree would perhaps have been preferable.

The actual personal use of mathematical instruments for graphical computations is probably largely foreign to many of the authors of the new text-books, and the treatment suffers on this account. There must be much future development before any text-book can be allowed to become crystallised.

Now that the study of pure geometry is to include numerical as well as graphical computations, it may become necessary, and it is certainly very desirable, to introduce simple tables of functions of angles so as to be able to solve right angled triangles completely, instead of being restricted as at present to the property of complementary angles and the use of Euclid i., 47.

The "Solid Geometry" by Dr. Hocevar will illustrate how this branch of the subject is presented to youths in Germany. Chapters i. and ii. deal with the properties of the line and plane in space, and the solid angle, but in a much less formal manner than is the case in Euclid xi. The remaining chapters relate to the properties and mensuration of the prism, cylinder, pyramid, cone, sphere and regular polyhedra. Exercises are provided in great variety, chiefly of the numerical type, and all necessary answers are collected at the end of the volume, where the reader will also find a useful index.

The translators say that, as the course of elementary plane geometry will be shortened on account of recent changes, teachers will be able to introduce solid geometry at an earlier period than formerly. The choice of the best complete school course of geometry is a very important matter at the present time. We should like to see solid geometry taught in connection with projection, and think that the elementary geometry of vectors should be introduced.

SHIP'S MAGNETISM.

Elementary Manual for the Deviations of the Compass in Iron Ships. By E. W. Creak, C.B., F.R.S., Retired Captain R.N. Pp. xii+150; with 4 charts. (London: J. D. Potter, 1903.)

IN his preface the author explains that the present work aims at being the successor of the "Elementary Manual" by the late Sir F. J. Evans. It is

"intended for the use of seamen of the Royal Navy and Mercantile Marine and Navigation Schools, and as an introduction to the Admiralty Manual for the Deviations of the Compass."

After a table of contents, there is a short introduction embodying some elementary definitions. Sections i. and ii., pp. 1–25, give an elementary description of the properties of magnets, with illustrations intended to supply a general idea of the action of the earth as a magnet, followed by a brief account of the phenomena of terrestrial magnetism which are of most importance to navigators. Section iii., pp. 26–42, describes the ordinary "Thomson" and liquid compasses and various auxiliary instruments. It also describes that temple of accuracy the Compass Observatory at Deptford, and gives valuable advice on such practical matters as the storage of compass cards, and the choice of a site for the standard compass on board ship. Sections iv. to vi., pp. 43–108, are mainly technical.

Section iv. treats of the "swinging" of ships to determine the deviations of the compass. It describes the sources of change in the deviation, more especially the effects due to "heeling" of the ship and to change of geographical position. It also gives some interesting particulars as to the large changes of deviation produced by the firing of heavy guns in warships. Section v. describes the effects of "soft" and "hard" iron. It introduces the reader to semicircular and quadrantal deviation by describing experiments whereby analogous effects can be produced by magnets or by soft iron situated near a compass.

Section vi. associates different constants in the ordinary mathematical theory of ship's magnetism—which the reader of the work is apparently intended to consult in the Admiralty Manual—with the action of imaginary magnets occupying specified positions in the ship. It then takes the actual results obtained in swinging certain warships, and shows how to construct deviation tables from them. This is done with great minuteness, and should be specially valuable to those who are unable to master the theoretical part of the subject. Section vii., pp. 109–131, treats of hollow iron spheres, Flinders bars, and other means of mechanical correction of the compass. There is a short account of the Peichl quadrantal corrector, which the author considers specially adapted for the case of compasses in conning towers of warships, where the earth's horizontal force is generally much reduced by the action of the ship's own magnetism. Amongst some concluding notes the author mentions the highly magnetisable and the nearly unmagnetisable alloys of iron recently discussed by Prof. Barrett and Mr. Hadfield as having a possible future in connection with compass work.

At the end of the book are some tables and a copious index. Table i. serves to facilitate the calculation of deviation tables. Table ii. tabulates some elementary trigonometrical functions. Tables iii. and iv. embody recommendations as to the dimensions of soft iron spheres and Flinders bars most suitable for the correction of deviation errors of assigned magnitude. At the end are charts of the earth's isogonal and isoclinal lines, and the lines of equal horizontal and vertical force, calculated for the epoch 1905.

So far, at least, as warships are concerned, the author's practical knowledge of the subject is probably unrivalled, and the value of the book as a mine of experience is hardly likely to be questioned. On the theoretical side there is more room for two opinions. The author takes a very humble—it is sincerely to be hoped too humble—view of the mathematical attainments of British navigators. His attitude to theory is the very antithesis of that of Mascart in his recent "Magnetisme Terrestre" (chapter xiv.). Mathematical results are occasionally introduced by a statement which does not amount to a complete proof, but might be mistaken for one, when a proof could be given without assuming advanced mathematical knowledge. Various of the references to magnetic and general theory scattered throughout the book are also capable of more exact statement from a physical standpoint.

The fact that the author defines the C.G.S. units in his introduction, but sticks to inches and other British or wholly arbitrary units in his text and charts, affords food for reflection. In one or two sections of the book there seem an appreciable number of minor misprints, more especially in one or two of the numerical examples, and attention might usefully be given to their elimination in the probable event of a second edition of the work being called for.

C. C.

OUR BOOK SHELF.

Encyclopaedia Biblica, a Critical Dictionary of the Literary, Political and Religious History, the Archaeology, Geography and Natural History of the Bible. Edited by the Rev. T. K. Cheyne, D.Litt., D.D., and J. Sutherland Black, M.A., LL.D. Vol. iv. Q to Z. Pp. xxxii+cols. 3989 to 5444. (A. and C. Black, 1903.)

THIS work, now completed, contains, as the publishers inform us, about as much printed matter as twelve volumes of the "Dictionary of National Biography." They have also published a thin-paper edition, which when bound in one volume is only about three inches thick. This encyclopædia has commanded for its

several departments the services of specially qualified writers, and will occupy for some time to come a high position as a work of reference for Biblical questions. As, however, it affords willing hospitality to the representatives of the most advanced criticism, it will be interesting in the course of a few years as a standard of comparison to show how far these opinions have been able to hold their own. Discussions of this kind occupy a large space even in geographical and historical articles and sometimes make it difficult to extricate physical facts from the maze of contradictory opinions. But these, when found, are clearly and accurately stated, as in the article "Trachonitis," which, however, is merely one of the more conspicuous of a large group. The maps also are a marked characteristic of the whole work—numerous, excellent of their kind, having in many cases contour lines and tints to indicate heights above and below sea level. That, for instance, which includes Trachonitis gives an excellent idea of the physical geography from north of Hermon to south of Pella in the Jordan valley. The short article on "Tabor" also is an admirable epitome of a place interesting both geographically and historically. That on "Tarshish" is a learned discussion on the identification of the place. In that on "Stones (Precious)" we find an almost exhaustive summary of what is known or conjectured about the gems of ancient times, with remarks on those in the high priest's breast-plate and the foundations of the vision city. The articles on natural history are not seldom from at least two contributors, one supplying the scientific the other the historical information. For the former, as under the word "Serpent," Mr. Shipley is responsible, so that we are sure of being on safe ground, while the other contributor adds much curious folklore. Indeed, the frequent references to this are not the least valuable part of the "Encyclopædia." Sir W. Thiselton-Dyer has contributed to the botanical articles, such as the "Vine," in this volume; that also on "Wine and Strong Drinks" is full of interesting information. Many of the theological and critical conclusions, as implied above, will doubtless be disputed, but as a compendium of information on history, archæology, geography, and all kindred topics the "Encyclopædia" is most valuable.

T. G. B.

Country Rambles: a Field Naturalist's and Country Lover's Note Book for a Year. By W. Percival Westell. Pp. xvi+312+xxxvi. (London: Henry J. Drane, 1903.) Price 10s. 6d.

Mr. Westell has made a serious mistake; he has let himself become the slave of his note-book. He seems to have made up his mind to write a year's diary for publication, with the result that he has filled it with trivialities which after a few pages will weary the reader, be he naturalist or not. On almost every page we find entries such as the following, which are taken quite at random:—"February 2. The snow will act as a deterrent on the singing of our feathered musicians, although I have often heard Robin and Wren singing in the very depth of winter, evidently cheered by the transient gleam." "March 21. I was tempted out into the garden early by the brilliant sunshine, and did a bit of gardening. Chaffinch 'pinking.' How delicate-looking the first Snowdrop as it peeps through the brown earth!" "June 10 (among other similar entries). What a variety of small beetles cross the path of the rambler, like dark little jewels darting about in the sunlight! There are many hairy caterpillars too. Cannot they move at a rate! How they curl up into the ball of protection!" No wonder that we read on the same page, "How often the Note-book comes out at this season!" Mr. Westell's mind has been working more upon his note-book than upon nature, and he would do well to leave it behind him for some time to come, and to reconstruct his ideas of observation and of a naturalist's work. When he touches a difficult or doubtful problem, he shows us at once what manner of naturalist he is. On p. 125 we read that "an instance is recorded by Herr Muller (*sic*), a well-known German Naturalist, of a Cuckoo sitting on, and hatching, her own fledgling. Three Cuckoo's eggs were found by Herr Muller in a hollow under a tussock of grass, &c." This statement seems to be taken from Dr. Japp's book on the Cuckoo; the Herr Muller is Adolf Müller, the forester; the occurrence he described, though, of course, in itself not impossible, has not been accepted by ornithologists whose opinions at any rate deserve some consideration, *e.g.* Prof. Newton, Mr. A. H. Evans, and Mr. Howard Saunders. Yet Mr. Westell retails this as a proved but extraordinary fact, without making the least attempt either to test the truth of it himself by going to the original source, or to collect the opinions of scientific naturalists on an alleged zoological fact of such great importance. He has to learn that there are other qualifications for a naturalist besides the constant companionship of a note-book and a binocular glass. We are very far from wishing to discourage the proper use of these, or the intelligent enjoyment and observation of nature, but what we cannot possibly encourage is the publication of bulky and expensive volumes like this (weighted, too, by photographs, only some of which are really excellent), which cannot satisfy the real naturalist or even the ordinary reader; and in this we are sorry to disagree with Mr. F. G. Aflalo, who has written a kindly preface to the book. It is to be hoped that Mr. Westell's love of the country and of nature will in the course of time be turned to better account.

Text-book of Organic Chemistry. By Prof. A. F. Holleman, translated by A. Jamieson Walker. Pp. xxvii+555. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1903). Price 10s. 6d. net.

A short time ago an English translation of Holleman's "Inorganic Chemistry" was welcomed by chemists in this country. The translation of the organic part has followed with commendable promptitude. This book is one of the best on organic chemistry which it has been our lot to read. Prof. Holleman approaches his subject with a freshness and vigour of style which make it delightful reading. Furthermore, he is not bound down by precedent or prejudice, and therefore follows no stereotyped style.

The book is written upon theoretical lines, and for this reason Prof. Holleman does not, as a rule, enter into descriptive details of manufacturing processes, and he only occasionally, as, *e.g.*, in the case of iodoform, describes even laboratory methods for preparing substances. This we consider is a good feature of the work—not that methods of preparation on a large scale should be neglected in teaching chemistry, but there are already many books which give *more* or *less* accurate details of manufacturing processes. And as for methods of laboratory preparation, these should be taught in the laboratory. Again, if the student is well grounded in his theory, as he should be if he carefully studies this book, he is less likely to look upon methods of preparation as if they were so many cookery receipts.

The book naturally falls under two heads, the aliphatic and the aromatic compounds. The aliphatic part is certainly more complete than the aromatic, which latter, considering that it contains, beside hydrocarbons of the benzene and naphthalene series, the terpenes, heterocyclic compounds such as pyrrole, furfuran, &c., and the albumens, is shorter than we should have

expected. The subject, however, is treated very concisely and generally very clearly. There is rather a want of lucidity, however, in his treatment of the synthesis of indigo on p. 512. The chapter on the diazo-compounds and the short *résumé* of Hantzsch's work in this direction are very good, and his remarks upon the electro-reduction of nitro compounds are also excellent.

Prof. Holleman pays particular attention to the physico-chemical side of the subject, an aspect which has been neglected by most writers of books on organic chemistry. On p. 188, for example, in the chapter upon polybasic acids, he devotes a long paragraph to their physical and chemical properties; again, on p. 196, he gives a clear explanation of the electro-synthesis of dibasic and other acids, while on p. 334 he describes Tafel's fine work on the electro-reduction of purine derivatives. In fact, one of the chief values of the work is the welding together of physical and organic chemistry.

The book is hardly suitable for beginners or for students who *want* (we will not say require) just a smattering of organic chemistry, but for the earnest student of the subject the work is one which can be most highly recommended. The style is good, the method of arrangement is excellent, and we think that there are few who will lay down the book after having studied it and feel disappointed.

Messrs. Wiley have produced the book in excellent style, and have spaced out the formulæ and equations in a lavish manner. Truly science knows no nationality—the book is written by a Hollander, translated by a Scotchman, and published by an American house.

F. M. P.

Education in Accordance with Natural Law. Suggestions for the Consideration of Parents, Teachers, and Social Reformers. By Charles B. Ingham. Pp. xi+125. (London: Novello and Co., Ltd.; New York: Novello, Ewer and Co., n.d.) Price 3s. net.

EVER since the publication of Rousseau's "Émile," with its well-known opening sentence, "Tout est bien sortant des mains de l'Auteur des choses, tout dégénère entre les mains de l'homme," there have been writers reflecting more or less satisfactorily the illuminating ray which Jean Jacques directed against the educational formalism of his day. Of course, if educational methods contravene the laws of nature, good results cannot be expected; but it is of supreme importance that writers venturing to define and formulate a system of education in conformity with natural law should at least first make sure that they understand the broad generalisations they call to their aid. An examination of Mr. Ingham's arguments gives rise to the suspicion that he has not completely mastered the conclusions at which men of science have arrived, and that his acquaintance with physical science is scarcely intimate. But Mr. Ingham is an experienced teacher, and has many sensible pieces of advice to offer, and even if the truths he advances are not new, they certainly are not universally adopted yet. To mention a few points on which the author has sound views is alone possible here. He advocates earnestly the need for more scientific methods in education; he pleads for more leisure time for boys and girls, in which they may follow their own devices; and he inveighs against the unsatisfactory early training of girls. He has not, we think, given science a sufficiently important place in the education of young people, but there can be little doubt that if parents could be persuaded to read the book they would have a clearer idea of what the aim of education should be.

A. T. S.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Psychophysical Interaction.

I AM interested by the letter of the professor of philosophy in the University of Birmingham on p. 126, and if your readers are not weary of the discussion—as I see no reason why they should be, since it is clearly a difficult question which must be discussed from time to time as science advances—I should like to add a few words.

When Prof. Muirhead says that my recent contention was advocated by Descartes, he is stating what is of interest, but what I did not know; I was not aware that the idea of energy, or even of momentum, was sufficiently clear in his era. But however this may be, he must not think that I regard the statement "that mind cannot produce energy" as axiomatic. It is a question not of axiom, but of fact. It seems to me that live things *do not* generate energy and *do* direct it; so I assert this, not as a necessity of thought, nor as an idea for which I have a special predilection, but simply as an experience. If Descartes maintained the same thesis, so much the more likely is it to be true.

Inert matter—all matter is inert—matter devoid of life then let us say, moves (technically, is accelerated) when and because it is pushed from behind. Live matter moves or is impelled to move from other motives; it is urged by anticipation of the future sometimes, by gratification of appetite for instance, or by avoidance of pain, often. A typical case is a costermonger's vehicle propelled by a bunch of carrots, or by the blows of a stick applied in indiscriminate profusion. There is nothing like that in storm or cataract or tide; nor is there anything like it in motor-car or railway-train, unless we include in the machinery the mind of the engineer.

Prof. Muirhead recommends a pacification of the question in the ultimate *nirvana* of idealistic monism. I am disposed to acquiesce ultimately in this destination, but I feel that there is something more proximate to be attained first. Philosophers go so fast and so far, they do not give the scientific man a chance; he wants to study the landscape and grub by the roadside. The ultimate outlook is doubtless there, very fine and attractive, like the setting sun; but the traveller to the west has much to see and much to do, and a constant gaze too far ahead may only dazzle him and unfit him for his proper work on the terrestrial sphere.

OLIVER LODGE.

Oxford, June 12.

THE opponents are not getting into close quarters. Dr. Hobson was irreproachable, but the others are using the word "force" all through the discussion, although it is the most unhappy word anyone could use in a controversy about fundamental physical conceptions. Its object is to enable us to contemplate one aspect of an action while we dismiss the other absolutely from our minds, because, when we want to give all our attention to one of the two bodies concerned, it helps us to ignore the other as much as possible.

It is remarkable also that Prof. Minchin should write that "guiding or deviating forces," if they allow the universe to keep its total energy intact, "infallibly alter its total momentum." Prof. Ward seems to have said the same thing, and the curious error remains without specific contradiction. Yet anyone who remembers that if there are n particles in the universe, there are $3n$ velocities for a sprite to amuse himself by tinkering with, will agree that he must, indeed, be a stupid or self-willed sprite who could not arrange to keep Σmv^2, $\Sigma m\dot{x}$, $\Sigma m\dot{y}$, and $\Sigma m\dot{z}$ unchanged while he disported himself with variations of the other $3n-4$ integrals.

Though that is merely a mistake on a side issue, an example on it will serve to put clearly the two different points of view. Suppose that there are two bodies of equal mass $2m$ moving due north with velocities of 9 and 1

units respectively, and without mutual action. The total energy is $m(9^2+1^2)=82m$, the total momentum due north is $2m(9+1)$, that due east is zero. At 12 o'clock the sprite wills that the first body should diminish its velocity due north to 5 and get one of 4 due east, while at the same time the second shall increase its velocity to 5 due north and get one of 4 due west. The bodies obey the sprite, of course, and even though he has by no means confined himself to "guiding or controlling forces," the energy remains the same, for $m(5^2+4^2+5^2+4^2)=82m$, and the total momentum north is $2m(5+5)$, and that east is $2m(4-4)$, *i.e.* $20m$ and 0, the same as before.

Now suppose a materialistic philosopher had been observing all this. Before 12 o'clock his observations of the continued uniform motion of the bodies would have led him to conclude that there was no mutual action between them, *i.e.* the law of the force was that it was zero. At 12 o'clock he would observe a change, and if ignorant that there was a sprite, would conclude that some other system, unseen by him, had come into collision with his system. If he is assured this is not the case, he will be driven to the only alternative, viz. that at 12 o'clock the *law of the action between them* had suddenly changed. (For the philosopher to say that a *force* had acted on the balls at 12 o'clock would be merely another way of saying that their motion had changed, because the definition of force, derived from Newton's laws, is "that which changes the state of motion of a body." Hence, whether he thought the action was due to a sprite, to an external material system, or to a change in the law of action between the bodies, the statement that at 12 o'clock a force had acted on each would be equally appropriate, and whatever supposition be adopted, the force would have the direction and magnitude, viz. that deduced by Newton's laws from the observed changes in the motion.)

Replace the two particles by the entire universe, and the point in dispute is really this. The physicist says, the changes in the motion of each particle at any instant depend solely on the positions of it and all the other particles, *according to laws which do not change with the time.* The form of the dependence, too, shows that there is but one future course of the motion—κ.λ.π.ν.'s singular solutions do *not* come in—and that it only needs infinite mathematical knowledge to calculate, from the positions and velocities at 12 o'clock to-day, and the unalterable laws of mutual action, what every particle of the system will be doing at, say, 3 o'clock three hundred years hence.

It is open to anyone to deny this position, but he ought, I think, to state exactly how far he does deny it, even though he may not be able to state exactly what he wishes to substitute for it. What it seems to me necessary for Sir Oliver Lodge to deny is that these laws apply to living matter. He *must say* that if the motions of the material particles of which protoplasm is composed be examined (in conjunction, of course, with those of the rest of the universe), our materialistic philosopher would be compelled to conclude that a change in the law of action had taken place—just as he would in the case of the two particles, if he were certified that they composed the whole universe. The materialist philosopher would then, I imagine, be prepared to receive with attention, at all events, Sir Oliver's assurance that these extraordinary changes were due to an exertion of will- or psychic-power on the part of the protoplasm, and that the law of mutual action between the material particles was not changed at all—it was only "supplemented," I suppose he would say, by the action of mind on matter.

Whether this is really so or not is perhaps open to that reasonable doubt which may exist on any matter which has not been made the subject of conclusive experiment, and any man is entitled to say that he doubts whether an observation of the motions of live matter would not reveal something incompatible with the supposition that the "forces" acting on the particles of the universe are determined according to any fixed law, *i.e.* a law independent of the time.

It would be interesting, but inappropriate, to discuss how far such a supposition will help people in regard to "the efficacy of prayer and many another practical outcome of religious belief," the reality of which Sir Oliver and many others consider to depend on the attitude taken in regard to it. Practically the effect of a general adoption of the supposition would be that for many years to come it would be thought to have removed the difficulties, but after a time these would crop up exactly as before. When men became more familiar with the conception of spirit, they would ask of it also, *what laws it followed*, and in the mental, as in the physical world, the conception of a necessary law of operation would assert its absolute sway among the higher minds who make knowledge their object. For it is only that which is subject to law which can be the object of knowledge. That which is capricious can only be the subject of memory and conjecture. It is not in this direction that any permanent solution of difficulties is to be sought.

EDWARD P. CULVERWELL.

Trinity College, Dublin, May 28.

IN relation to the letters on "Psychophysical Interaction" appearing in NATURE, the initial questioning the discussion works back to is whether we are to recognise in mind the mere knower, or manipulator, as well, of animal action. In relation to such a questioning it may be of use to consider that what is inferred concerning mind as existing anywhere outside oneself is inferred by study of action displays. We possess no faculty which can directly become aware of the psychical outside oneself. It is in action we see it, if at all. The study of animal intelligence infers as to animal intelligence by seeing it in animal action. We meet with peculiar kinds of actions which seem to require intelligence for their origin; and therefore surmise as to animal intelligence. The observation holds of the human intelligences with which we come in contact. We can only get to know the mind of a man through his action that he acts intelligently; therefore he must be intelligent. A man may speak his ideas to us, and by his speaking convince us of his inlying intelligence; but in ultimate analysis talking is as much a muscular performance as walking. Or he may write his thoughts, and we by reading may see in what he has written that he has ideas; but if the mind is mere knower it cannot manipulate action to the writing down of ideas, and therefore this is effected in some other way. For all we may know to the contrary, the man vacant of mind may be more at large than we are apt to suspect, for by the mechanical hypothesis a man may talk rationally and yet not have ideas.

The mechanical hypothesis disposes of the actions of animals by the theory of their being fitted and adapted in reciprocal relation to environment by process of natural selection. Variations in action take place in species, and the species which are favoured with favourable variations in action in the long run survive. The theory explains many of the adjustments of animal action, but not all. There are instances to which the hypothesis can never extend, and they are the instances of action which are put in in circumstances where there is no scope for natural selection to work. Take, for instance, a man learning to play a cornet. The learning to play a cornet is the putting in of an action process, and as such is worthy of biologic consideration. The man learns to play the instrument by manipulating his breathing and fingering the keys. He studies the music before him, and internally, and mentally, decides upon the fingering which is appropriate. His breathing into the instrument is timed by his mental translation of signs given by the printed page. Each stage of his practising is revised by hearing. Where he plays a false note he goes back, and exercises extra attention to do better.

The entire action of players in a cricket field is action adjusted in relation to the motion of the ball. It is action determined by seeing. Deduct the seeing and it cannot be done. And cricket has not been long enough in existence for natural selection to have anything to do with it. So the editing of NATURE is an intelligent-mechanical process. Deduct the intelligence in that process, and it cannot be done. The expert conjurer, equilibrist, or trick cyclist depends upon the alertness of his sensations for the correctness of his performance.

Apparently in the whole proceeding of animal action, excepting the old established automatic, knowing, seeing, hearing, feeling, plays its part. Ants will eat sugar but not saccharin. The *taste* to them is not as sugar. So

the lion runs to his prey with his nose to the ground, and the action of the bloodhound is valuable on account of his fine scent. It seems with mind as mere knower and non-manipulator of action these performances could not be put through. A. Bowman.

144 Well Street, Hackney, May 26.

Musical Sands.

May I record the discovery of musical sands at places along the shore between Ramsgate and Kingsgate. The sand occurs in small patches close to the chalk cliffs, the largest patch being found at Joss Gap. In composition the sand is very similar to that of Studland Bay, but the individual grains are more polished, and the proportion of denser minerals far higher. Of course, the sand can only be experimented upon when it has been uncovered by the sea for a sufficient length of time to enable it to become dry, and it gives remarkable results when tested in the ordinary way—especially when placed in a china vessel and struck with a wooden plunger.

June 8. Cecil Carus-Wilson.

THE STUDY OF BACTERIAL TOXINS.

The study of the toxins produced by bacteria is one of the most important branches of bacteriological research. The solution of some of the main problems of immunity and disease depends upon the knowledge that can be gained with reference to the nature of the bacterial toxins and their mode of action upon the animal body.

The methods introduced by Pasteur, Koch, and other observers have rendered it possible to detect and to isolate the specific agents in a number of infective processes. The number of infective diseases that have been definitely associated with the action of bacteria is considerable, *e.g.* tuberculosis, cholera, diphtheria, typhoid fever, &c.

It was natural that the earliest attempts to prevent the invasion of the animal body by these microparasites should be based more or less on the principles of Jennerian vaccination. An attenuated virus, for example, was taken and used directly as a vaccine in order to produce, if possible, an active immunity to the disease in question. This system of protective inoculation was tested in a number of diseases, and notably in infective diseases of the lower animals. The anthrax vaccine employed for the protection of cattle and sheep is a typical example of such immunising methods, whilst in recent years analogous methods of protective inoculation have been extensively used in certain diseases of man.

The study of the microparasites associated with diphtheria and tetanus showed that organisms of this type possessed not merely infective but likewise marked toxic properties. It was further established that these toxic properties were the determining factors in the production of the graver symptoms in cases of diphtheria and tetanus. It therefore became apparent that in diseases of this order, the point of cardinal importance was to combat, if possible, the toxins produced in their course. The laboratory experiments made with the diphtheria and tetanus organisms demonstrated that the poisons were soluble products of the bacterial cells in question, and were excreted into the nutrient fluids in which they had been cultivated. These toxins were proved to be of a specific nature, as they reproduced the essential general symptoms of the diseases.

Diphtheria and tetanus are therefore intoxications of the body, due to the action of specific soluble poisons produced by the parasites at the seat of infection. The toxins, on being introduced into suitable animals in carefully regulated doses, produced an active immunisation of the animals characterised by the formation in their blood of anti-bodies as regards the toxins in question—in other words, antitoxins resulted. The antitoxic serum, when added to the toxin *in vitro*, robbed the toxin of its poisonous properties, and, probably in virtue of some chemical combination between toxin and antitoxin, a neutral mixture resulted. The serum containing these specific anti-bodies, on introduction into other animals, conferred on them a passive immunity. They were protected against the action of the toxin in question, and, most important of all, the serum was efficacious in the case of an already existing intoxication—it possessed curative as well as protective properties. If a large animal, such as a horse, was actively immunised by injection of the soluble toxins, considerable quantities of these antitoxic substances were formed and accumulated in its blood and blood-serum. In this way the serum of an animal highly charged with antitoxins became a valuable and innocuous vehicle for the introduction of these preventive and curative substances into the human system. The natural defensive forces of the body were thereby reinforced, and in the right direction. This method of serum therapeutics has had brilliant results in the case of diphtheria, and has been demonstrated to be a feasible therapeutic method in the case of tetanus. These maladies belong to the group of *intoxicative* diseases. There remained, on the other hand, a large number of diseases in which a general multiplication of the microorganisms in their host appeared to be the salient feature. It has been usual to call these, in contradistinction to the former, *infective* diseases. The successful results in the case of diphtheria led to the extensive study on similar lines of infective organisms generally. A systematic search was made for soluble bacterial poisons, as their detection would be likely to lead to valuable additions to antitoxic serum therapeutics.

The researches in this direction met with unexpected difficulties and disappointments. The results obtained in the case of diphtheria and tetanus were not found to be of general application. Each organism had therefore to be taken on its own merits, and individually studied. It speedily became apparent that, as regards a considerable number of infective agents, the conditions were not the same. On cultivation in fluid media no distinct evidence of the production of soluble poisons could be obtained, or, if present, they were so in an inappreciable amount. The attempts, therefore, to produce antitoxins by the injection of such culture fluids into animals did not promise to be of much practical value. This, as a matter of fact, has proved to be the case; the various serums prepared were found to possess little or no curative value. Many infective organisms did not apparently produce their injurious effects through the agency of soluble toxins, and consequently curative methods based on the assumption resulted in failure. Research was thrown back once more upon the living infective agents, and the possibilities there might be of protecting the body directly against their invasions, or, in other words, of producing not a poison but a bacterial immunity. Bactericidal substances were found to be present in the blood of individuals who had passed through an attack of certain infective diseases, and the bactericidal action was specific as regards the infective agent in each case. For example, the blood of a patient recovering from typhoid fever is bactericidal to the typhoid organism. In the absence of soluble immunising products, there was a strong presumption that these substances were to be sought for within the bodies of the bacteria. The bacteria in that case, if injected directly into the system, would tend to produce an active immunisation of the body, and would reinforce the bactericidal properties of the tissues in specific directions. The method most generally favoured for this purpose was the in-

jection of killed cultures of the bacteria in question. The typical examples are the vaccines employed in cholera, plague, and typhoid fever for prophylactic purposes. The killed cultures of the several organisms are injected directly into the healthy individual in calculated doses, and the method is generally described as one of protective inoculation. In all these cases the immunising value of the vaccine appears to lie essentially in the dead bodies of the bacteria it contains. The active immunisation that occurs depends upon a solution of the dead bacteria by the blood and tissues, and a consequent liberation of any immunising substances peculiar to the cells. The properties developed by the blood of the treated individuals are antibacterial and not antitoxic, or if so only to a small degree. If one assumes that the properties of the blood in such instances are purely of a bacteriolytic character, there would be no protection necessarily afforded against any poisonous substances that might be present in the bacterial cells, and liberated from them in the process of their dissolution or in the course of the disease. Whatever the point of view, the conviction is now an established one that in a number of infective diseases it is the direct study of the specific cellular agents that will be most likely to lead to results of therapeutic value. The important conclusion has been arrived at that there are two kinds of bacterial poisons—soluble toxins, which are secreted by the bacteria, and cellular toxins, which are contained within their body substance. The toxins may be either extra- or intracellular. The diphtheria and tetanus poisons, already referred to, are examples of the first group, and are to be met with in the nutrient fluids in which the organisms are cultivated. The typhoid and plague toxins are examples of the second group, and are practically absent from the culture fluids in which the specific organisms are grown. The poisonous principles are contained within the bodies of the microbes. The dead bodies of typhoid bacilli, although destitute of all infective properties, are yet toxic when introduced into animals in virtue of the intracellular toxins they contain—the animals succumb to an intoxication.

In the case of many diseases formerly regarded as purely infective in character, it has now become apparent that, in addition to the infective, the poisonous properties of the invading bacterial cells have to be taken into account. Any therapeutic endeavours of a curative character, it appears to the writer, ought therefore to be based on the presumption that every infection implies, sooner or later, an intoxication.

The number of infective organisms in connection with which research has failed to demonstrate soluble toxins of possible clinical importance is considerable. The presumption in such cases is that the missing toxins are intracellular, and that if antitoxic principles of treatment are to be devised they must be based on a knowledge of the nature and properteis of these cellular poisons. A vital question consequently for bacteriologists at the present moment is the relation of intracellular toxins to immunity. The study of the intracellular constituents of bacteria has, it will be obvious, assumed great importance on account of the issues involved. It is interesting to note, by way of parenthesis, how generally biological research is being attracted to the direct study of the cell, and how widely it is being recognised that the processes of life, whether of a natural or a morbid character, are in their essentials of an intracellular nature. In this respect the researches of Buchner were of wide biological significance. They were suggestive of much more than a theory of a cell-free alcoholic fermentation of sugars. And in the bacteriological field the original investigations of Koch, and the preparation by him of tuberculin from the tubercle bacillus, drew general attention to the important results that might be obtained from the study of the bacterial cell and its constituents. Various methods are employed with this object in view. The killed cultures of bacteria may be used, and their physiological effects determined by injection into animals, or by chemical means extracts may be prepared from the organisms and their effects similarly tested, or mechanical methods may be adopted in order to obtain the fresh intracellular juices.

In the investigations carried out by the writer, in conjunction with Mr. Rowland, during the past four years, mechanical methods were selected as the best adapted for the general purpose in view, viz. the study of the intracellular toxins and ferments of bacteria and other cells. The first essential was the elaboration of a method to obtain the plasma of such minute cells as the bacteria. The aim was to procure the fresh cell juices and to avoid their possible modification by heat or by chemical agents. For this purpose the cells were mechanically triturated by a *cold* grinding process. The necessary cold was most conveniently obtained by the use of liquid air. It was found that the cells could be mechanically broken up when in the brittle condition produced by immersion in liquid air, without any admixture of sand or other foreign substances. A number of bacteria and other cells have been triturated in this fashion, and their fresh intracellular constituents obtained. The results in the case of the typhoid bacillus will serve to illustrate the general line of research being followed. The typhoid organisms were grown on ordinary beef broth agar, and after careful washing with distilled water were disintegrated in a mechanical contrivance at the temperature of liquid air ($-180°$ C.). The disintegrated mass was freed from insoluble suspended particles by centrifugalisation, and an opalescent fluid, representing the cell-juices of the organism, resulted. The typhoid cell-juices obtained by this method, on inoculation into animals in small doses, invariably proved toxic or fatal. It was therefore concluded that the typhoid bacillus contains within itself an intracellular toxin and that it is possible to extract it from the organism.

The typhoid cell-juices were further tested for immunising and other properties, and were administered subcutaneously to suitable animals. The experiments showed that the serum of the monkey, after injection of the typhoid cell-juices, possessed antibacterial and antitoxic properties, inasmuch as the serum protected experimental animals against the typhoid bacilli, and also against the intracellular toxin obtained from them. The serum was found to possess curative and preventive properties as regards the typhoid bacillus and the intracellular toxin extracted from the same organism. The research thus afforded proof that in the case of one species of pathogenic bacterium, the intracellular juices of the organism, when injected into a suitable animal, give rise to the production of a serum which is both bactericidal to the organism itself and antitoxic as regards a toxin contained in its substance.

The results already obtained are such as to encourage further inquiry as to the possibility of their practical application in the case of typhoid fever, as well as to determine in how far such properties of the cell-juice are shared by other pathogenic microbes. The particular method employed has proved of value in the study of a distinct class of toxins and ferments brought to light by recent research which are contained and operate within the cell and bacterium, in contradistinction to the well-known class of toxins which are extracellular, *i.e.* extruded during life from the cell to the surrounding medium. The importance attached to the intracellular group of bacterial poisons is evidenced by the increasing attention that is now being paid to their study.

ALLAN MACFADYEN.

SCIENTIFIC KITE FLYING.

SYSTEMATIC observations of the temperature and humidity of the upper air have been made for many years past, both in America and on the Continent, kites being the means employed mostly in America, and kites and balloons on the Continent.

The plan adopted is to send up a kite of some 60 to 80 square feet of lifting surface, the line used being steel music wire instead of string, additional kites being attached to the line as occasion requires. The end kite, or the line close to it, carries a self-recording instrument, and in this way observations at a height approximating to or even exceeding three miles are sometimes obtained, although it is not often that the air motion in the various strata is such as to render a height of more than 10,000 feet possible. The obstacle to be overcome is the pressure of the wind upon the line, which soon reduces the angular altitude of the kite, and it is on this account, rather than on the greater strength of steel for the same weight, that steel music wire is preferable to string, the resistance of the wire on account of its smaller section being so much less.

FIG. 1.—Rhombus kite, 7 ft. 6 in. by 6 ft. by 3 ft. 6 in.

There are few days on which a small elevation may not be reached by a kite, but days really suitable are not plentiful. It is self-evident that a suitable wind is the first requisite, and to obtain a great height a suitable wind must prevail from the lowest to the highest strata reached. We cannot, of course, alter the wind, but fortunately we are able to move the point to which the kite line is attached, and this practically comes to the same thing as altering the force of the wind. The most convenient means of doing this is to fly the kites from the deck of a steam vessel, and during last summer observations were thus obtained for seven weeks almost daily.

The work was inaugurated by a committee of the Royal Meteorological Society, cooperating with a committee appointed by the British Association.[1] They hired a small steam tug of 55 feet length and 14 feet 6 inches beam. The vessel was stationed at Crinan, which is at the north end of the Crinan Canal, on the west coast of Scotland, and, Sundays excepted, kite ascents were made from her deck every day, no matter what the weather, from July 8 to August 26. The vessel could not steam more than seven knots, and the wind velocity necessary to raise a kite is from nine to twelve knots, so that on occasions when it was a dead calm no kite could be started. It happened, however, that no day was calm throughout, so that some time during the hours of daylight the opportunity of reaching at least 1500 feet elevation was afforded. Had the tug been capable of ten instead of seven knots, I have little doubt but that a height of 5000 feet might have been attained every day.

Using one or two kites only, no difficulty was experienced. The most troublesome point was getting the kite together when the wind was strong. The tug was small, and had no bulwarks, so that there was no shelter of any kind on deck, but her smallness was certainly an advantage in another way. A larger vessel would have produced eddies in the wind, and probably have rendered it difficult to start the kite direct from the deck. As it was we had no trouble, and it was very seldom that a kite failed to rise steadily from the starting point. In calm weather the vessel was

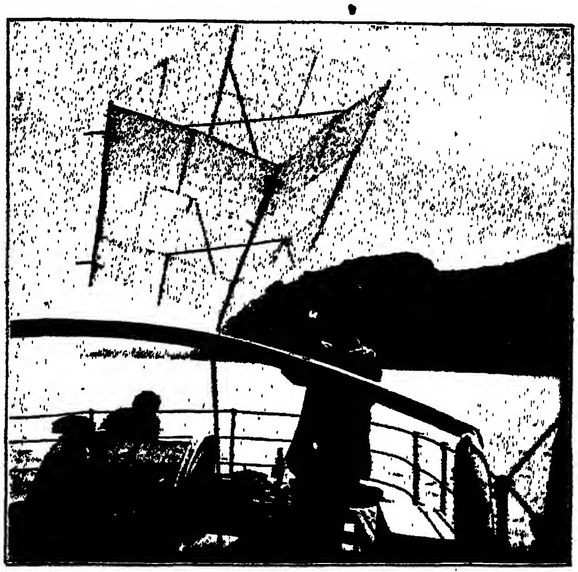


FIG. 2.—Starting a kite from the tug.

kept steaming against, or nearly against, the wind so as to produce sufficient relative motion to raise and maintain the kites. In rough weather she was taken out against the wind for some ten or twenty miles until a position was attained from which a clear run down the wind was possible, and the kite was then started. A wind of force 5 on the Beaufort scale is the most suitable wind for kite flying. This is known technically as a fresh breeze, and is sufficient to produce a moderate amount of white on the sea surface. One of the kites of the usual size for scientific kite flying will, in such a breeze, exert a pull of about 50 lbs. The wire used will bear a strain of some 300 lbs., and weighs about 16 lbs. to the mile, so that one kite in such circumstances will take nearly two miles of wire, and, if it be a good one, will raise the instruments to about 5000 or 6000 feet. The pull of 50 lbs. is well within the limits of stability of the kites, and is on the whole about the most convenient to work with, if one can be certain of the goodness of the kite. At Crinan the tug was so manœuvred that a tension of 40 lbs. for each kite on the line might be main-

[1] See paper on "The Method of Kite-flying from a Steam Vessel, and Meteorological Observations obtained thereby off the West Coast of Scotland" (*Quarterly Journal of the Royal Meteorological Society*, April).

tained, but kite flying is an art of which we were then without previous experience, and so it was well to err on the safe side. A steam vessel is extremely convenient for kite flying, as by altering either her speed or direction the strain upon the wire, provided the vessel is not already going full speed against or with the wind, can be varied with the utmost nicety.

With more than two kites difficulties often occur, owing to the fact that very different wind velocities may prevail at different heights. If the wind is greatest at the surface, adding more kites does not add appreciably to the height of the end one, since no kite can rise into a stratum in which it does not find sufficient wind. This sometimes occurred, but the more usual case was that the wind force increased too rapidly with elevation, so that if the tug were used to increase the relative surface wind to suit the lower kites, it added too much to the strength of the upper wind, and by unduly increasing the force upon the upper kites, put a dangerously high tension upon the wire. If, on the other hand, the tug were moved to suit the upper kites, the lower ones might be becalmed, and useless for lifting purposes, or perhaps even fall into the sea.

Very interesting results have been obtained from these experiments, both in America and on the Continent, but it has been felt that the conditions prevailing over the large oceans are very likely different from those over the continents. The cyclonic disturbances, on the motion of which our weather very largely depends, certainly show a preference for the sea, and it was in the hope that some light might be thrown on their mechanism, and the causes which produce them, that a locality on the west coast of Scotland was chosen for the observations. The evidence obtained from last summer's work is not sufficient to be conclusive, but so far as it goes it tends to show that as a depression approaches, the decrease of temperature with elevation becomes less than it was before. This was the case with every depression that passed while the experiments were in progress, and it leads to the conclusion that the upper air in the neighbourhood of a cyclone is relatively warm, and that the cyclones are convectional effects.

A further result of the observations shows that the temperature of Ben Nevis was in every instance below that of the free air at the same level some sixty miles to the south-west, often from 5° to 8° F. below. That the two air temperatures should have agreed was hardly expected, but the difference was very marked, and it is desirable that the experiments should be repeated in the same locality to confirm the result. The fact, however, that the summit of the mountain is so often wrapped in clouds, when the sky is clear elsewhere, tends to show that the summit must be unduly cold, and it seems likely that the effect is produced by the adiabatic cooling of the air as it is forced up the mountain slope. In fact, the cloud level on all the mountains and hills in the neighbourhood was always much below the point at which the kites entered the clouds. It is also known from the differences in the barometer on the Ben and the values computed from the Fort William readings that the temperature of the intermediate layers of air is not truly represented by the mean derived from the summit and sea-level temperatures.

England being so near the usual cyclonic tracks, observations on the upper air are of especial interest, and it is very desirable that a permanent station for the purpose should be established. It may perhaps be found that unmanned balloons too often fall into the sea to be usefully employed, but the attempt is well worth a trial, and so far as kite observations are concerned, the only difficulty is the financial one.

W. H. Dines.

A NATIONAL DIPLOMA IN AGRICULTURE.

A SO-CALLED national diploma in the science and practice of agriculture can now be obtained by any student who passes the necessary examinations. This diploma has undoubtedly a high-sounding title—it would be difficult indeed to suggest a title of greater weight—and it is therefore not surprising that the number of students entering each year for the examination is steadily increasing, and that successful students should be proud to write the important letters N.D.A. after their names. Now we greatly wish that a truly national diploma in agriculture could be obtained; that a well-ordered scheme of education and examination were authoritatively set forth; and that the skill and knowledge of the nation should be really brought to bear upon the subject. The diploma in question has no right to the title of "national." It is granted by a joint committee of two agricultural societies—the Royal Agricultural Society of England and the Highland and Agricultural Society of Scotland—it should therefore be designated "the agricultural societies' diploma." To claim for it a national importance, and thus to imply that it ranks above all other agricultural diplomas, is simply to mislead the public, and to assert a position to which it has absolutely no right. The question of continuing to grant the diploma in question has lately entered a critical stage; it may be of service, therefore, to set forth in few words the origin and character of the examinations on which it is based.

It must be reckoned as greatly to the credit of the two agricultural societies we have just named that they have been for many years engaged in promoting agricultural education by means of examinations. The Highland and Agricultural Society of Scotland was at the pains to obtain a supplementary charter in 1856 in order that it might add agricultural education to the other functions of the Society. This charter sets forth that "in order to encourage the proper education of agriculturists in Scotland" the Society is empowered to appoint a committee consisting of the professors of agriculture, anatomy, botany, chemistry, natural history, and technology in the University of Edinburgh, with sundry public officials, and seven members chosen by the Society. This committee is to appoint a board of examiners, and to grant diplomas bearing the corporate seal of the Society. The Society has acted on the powers thus given; it has conducted annual examinations in Edinburgh from 1858 to 1899, and granted diplomas according to the terms of its charter.

The Royal Agricultural Society of England possesses no such definite authority as that given to the Highland Society for the conduct of examinations or the granting of diplomas; its charter, given in 1840, merely authorises it "to take measures for the improvement of the education of those who depend upon the cultivation of the soil for their support." The Society has conducted annual examinations in England from 1868 to 1899. Up to 1897 the successful candidates received certificates, but in 1898 and 1899 diplomas were granted.

In 1897 the two societies nominated a joint board of examiners to conduct examinations in the science and practice of dairying, and annual examinations have since been regularly held both in England and Scotland. The successful candidates receive a national diploma in the science and practice of dairying.

In 1899 the two societies took a further step, and appointed a joint board of examiners to conduct examinations in the science and practice of agriculture; the examinations hitherto conducted by the separate societies then ceased. The first examination by the joint board was held in 1900, and such examinations

have since been regularly continued. The examination is always held in England. The successful candidates receive a national diploma in the science and practice of agriculture.

Such, then, is the history of the diploma of which we are at present speaking. It is, of course, obvious that any society or societies may hold an examination in any subject they please, and grant certificates to successful candidates; but may such bodies, without proper authority, presume to confer a national diploma? That is the serious question before us. The charter of the Highland Society undoubtedly authorises it to confer a diploma in agriculture in Scotland, but the language of its charter, which we have already quoted, clearly limits its authority to that country. This fact is so manifest that we are now told by the agricultural Press that the Highland Society intends to apply to His Majesty's Government for an extension of its charter. The charter of the English Society contains no authority to grant diplomas.

We have already said that a national diploma in agriculture appears to us as a desirable thing, if it could be granted by national authority and awarded only to thoroughly trained men. If powers to grant such a diploma are now being sought, the terms of the charter granted many years ago to the Highland Society supply some pertinent suggestions. If the diploma is to be really national, if it is to be stamped with a national authority, the schemes of education and examination laid down must not be decided on by the members of two agricultural societies. The charter of the Highland Society names six professors of the University of Edinburgh as members of the education committee. A charter granted with a similar object now would naturally take a similar line, but it would not limit itself to the University of Edinburgh. The *ex officio* members of a national committee should clearly include professors from other British Universities, and representatives of the Government Boards of Agriculture and Education. Until such a general body is constituted and authorised to grant diplomas, it is a misuse of language to speak of a national diploma in agriculture or dairying.

We turn now to the character of the examination at present held for the award of the so-called national diploma. If the diploma granted merely professed to be an agricultural societies' diploma, it would be scarcely necessary to speak on the subject; but the claim to national rank surely implies a diploma examination of first-rate quality, and if it fails of this it certainly demands public criticism.

The diploma in question is granted solely on the result of examinations, no previous course of training being required. The examinations for the diploma embrace many branches of elementary science; half of the subjects are taken by the candidate in his first year and half in his second year. The syllabuses published of the subjects for examination are undoubtedly meagre, some of them strikingly so. This is a real disadvantage, as the teachers who are preparing students for these examinations naturally limit their instructions to the syllabus. The examinations are both written and oral, but include no laboratory work. In each subject the written examination is limited to two hours, save in the case of practical agriculture to which three hours are allotted. The candidates are generally directed to attempt every question in the paper, six to ten questions being set. The whole of the subject of practical agriculture is dealt with in one paper of three hours, followed by an oral examination. The tests applied by the examiners would thus appear to be decidedly superficial. The number of marks allotted to each subject must be supposed to indicate their relative importance in the eyes of the examining board. We find that book-keeping and agricultural chemistry receive the same number of marks, while general chemistry and veterinary science each receive half as many marks as book-keeping! It is, indeed, essential that anyone who is to practise farming should pass an examination in book-keeping, but that a knowledge of agricultural chemistry should be taken to represent no greater previous study or no greater fitness for dealing with the problems of agriculture than a mastery of the art of posting trade accounts is certainly remarkable, and surely indicates a low appreciation of agricultural science by the examining board.

We have now done. The questions we have raised demand earnest attention. The character of our whole system of agricultural education depends on the standard set by what is apparently its highest grade. The present diploma has been given a title to which it has no right, and it has failed to justify by its excellence the rank which has been sought for it.

THE INTERNATIONAL CONGRESS FOR APPLIED CHEMISTRY.

THE fifth International Congress for Applied Chemistry, which sat in the Reichstags-Gebäude of Berlin from June 2 to 8 under the masterly presidency of Dr. Otto N. Witt, professor at the Technical High School of Charlottenburg, will be remembered as a great representative meeting. The actual attendance figure was not announced, probably because many of the members who had previously secured their tickets forgot to enter their names on arrival. But the figure cannot much fall short of 2700. Preparations had originally been made for 1500 members. About 2500 had arrived by the time of the opening of the Congress, and those joining later could not be favoured with invitations to the many pleasant receptions and excursions which had been arranged. Everything possible was, however, done by the local committee, over which Dr. J. E. Holtz presided, and by the general secretaries, Dr. Pulvermacher and T. Karwath. Everybody could gain admission to the grand "Commers." The Diet had made a grant of 15,000 marks, donations had poured in from many sides, and private hospitality was practised most liberally. Chemical works, in the strict sense of the word, were not opened to members, but visits to special exhibitions, scientific institutes, and manufactories would have supplied an amply long and instructive programme even if the sectional proceedings had left members far more spare time than they did. Some sections deliberated from 9 to 1, and again from 3 to 6 and later. The ladies were excellently taken care of during the whole congress week.

Though a more suitable and dignified place for the meeting could not have been found than the magnificent palace of the Imperial Diet, the large committee rooms of which afforded ample accommodation for all the sections, a parliament building is not a laboratory, and some of the sections had to emigrate for their experimental demonstrations. Section vii., fermentation and starch, sat mostly in the Institute for Fermentation, and had an exhibition of its own in the grounds adjoining this institute. Section ix., photochemistry, was isolated—and rather neglected, too—in the Technical High School at Charlottenburg. Section x., electrochemistry and physical chemistry, found a home in the Physical Institute of the University, close to the Reichstag. Each section had its official luncheon restaurant. The plenary meetings took place in the large hall of the Reichstag.

On Tuesday evening, June 2, President Witt welcomed the members in German, French, and English. The formal opening meeting on the next morning, at which Prince Frederick Henry represented the Emperor, was addressed by Prof. Witt; Secretary of State Count Posadowsky-Wehner, on behalf of the Empire; the Prussian Minister of Education, Dr. Studt; Mayor Dr. Reicke, on behalf of the City of Berlin; representatives of the learned and technical bodies which had taken part in the organisation; and the official delegates, Dr. Tilden speaking for Great Britain. As thirty Governments had sent delegates, the representative of Switzerland, Prof. Lunge, was heard as speaker for the minor States. There was a beautiful passage in President Witt's eloquent welcome: The flames of special research burn in the many chapels, and the Congress unites all the worshippers of the one universal science. Mayor Reicke also earned warm applause. The honorary president of the Congress, the veteran chemist Prof. Clemens Winkler, was not well enough to attend. The vice-presidents were Drs. H. Böttinger, M Delbrück, C. von Martius, E. A. Merck. The honorary vice-presidents, Moissan, Meldola, Piutti, and Christomanos, were appointed by acclamation.

The second plenary meeting on Friday morning was devoted to lectures. H. Moissan demonstrated some of the properties of the alkali hydrides which he has recently prepared. Potassium hydride is a snowy mass, which has to be kept in sealed tubes, and decomposes, when heated, into potassium and hydrogen; a tube was broken under water to exemplify this. Carbonic acid gas decomposes the mass, but the decomposition does not occur in the second of two tubes joined in series, because the presence of a trace of moisture in the CO_2 is necessary, nor does it occur below $-65°$ C. The KH_2 does not conduct the electric current, not even when fused, and the hydrogen in these alloys does not behave like a metal any more than it resembles metal in its liquid state.

Sir William Crookes then gave his discourse on modern views on matter: the realisation of a dream, dealing with speculations which the mysterious radioactive emanations suggest or support, and alluding to a fatal atomic dissociation which works when we brush a piece of glass with silk, and in sunshine and raindrops, in lightning and flames; protyle the formless mist, might once more reign supreme.

J. H. van 't Hoff then explained how the phase-law of Willard Gibbs enables us to understand the formation of natural salt deposits, referring to the influence of temperature, pressure, and time; the higher the basicity of the acid and the valency of the metal, the longer can a state of supersaturation exist, and when we have dibasic acids and bivalent metals, the addition of a solid crystal of the respective salt will no longer produce the crystallisation which is instantaneous in the case of Glauber salt.

The retrospective view of the ammonia-soda process, by E. Solvay (Brussels), did not enter into any detail. In the next lecture, on auto-oxidation, Carl Engler (Karlsruhe) went in a certain measure back to Schönbein's ozone and antozone. Oxygen does not appear to combine in single atoms, but always as a whole molecule, giving an unsaturated compound which yields a peroxide; this peroxide then, by giving off half of its oxygen, forms oxides, and we may distinguish two classes of bodies in this respect. The auto-oxidators bind the oxygen to peroxide and pass half of it on to the acceptor, which itself cannot bind the atmospheric oxygen. We have thus, in the animal and vegetable kingdoms, to which these arguments particularly apply, peculiar catalytic processes. Engler made reference to a paper, read by L. Woehler (Karlsruhe), who has extracted 18 per cent. of Pt from spongy platinum by hydrochloric acid, precipitated a protohydrate from the solution, and oxidised platinum, both as foil and sponge, by heating it in oxygen; a piece of foil absorbed 1·9 per cent. of oxygen in thirty-seven days.

The last general lecture was given by G. Kraemer, of Berlin, on coal tar researches.

The concluding plenary meeting had to pass or reject the sectional resolutions which are to be presented to the permanent committee of the International Congresses for Applied Chemistry, and also to select the place for the next meeting. Most of the numerous resolutions, concerning the drawing up of analytical reports, the undesirability of characterising reagents simply as pure, the specialisation of the Trauzl test (explosions within lead chambers), the transport of explosives, a uniform method of compiling statistics of accidents, the soda test of petroleum, the prohibition of additions of starch to press yeast, and other points were approved of without discussion. The electrochemical units, recommended by Nernst, Warburg, and Strecker, on behalf of the Bunsen Gesellschaft, the Physical Society, and the Elektrotechnische Verein of Berlin, for general use in publications, were adopted by the Congress, with an amendment by A. A. Noyes (Boston) that a committee of the Bunsen Gesellschaft should cooperate with other societies in order to make the system more comprehensive. The proposals of Section xi., legal and economical questions, however, met with opposition. It was not unreasonably complained that the resolutions were not in print before the meeting, though they had been published in the daily journals—not always in their final versions, however—and the meeting declined to sanction: that the registration as trade marks of words is not to be considered illegal for the reason that those words had previously been used in a definite sense. The assembly agreed to the general prohibition of white phosphorus matches, and recommended proper care of the employés in chemical works as a moral obligation the observance of which would serve the manufacturer's own interest. The two International Commissions, for analysis (created in 1900, chairman, Prof. Lunge) and for manures and fodders (created in 1898, chairman, Dr. von Grueber, of Malmö) were reappointed. The sugar chemists wished to settle their analytical methods for themselves. A new commission is to be elected for compiling a codex alimentarius.

The remarkable skill, tact, and firmness with which President Witt guided the assembly in these discussions were again called into requisition when the place of the next meeting was to be decided. On behalf of the Italian Government, the City of Rome, and the learned societies of Italy, Prof. Paterno di Sessa invited the congress to Rome. In accordance with a resolution unanimously passed by the British members of the Congress in a special meeting, at which thirty-eight members were present, Mr. I. Levinstein, president of the Society of Chemical Industry, asked the Congress to come to London in 1906, on behalf of that society and other societies interested; Dr. Tilden, the British delegate, supported the invitation. Both Italy and Great Britain had previously offered hospitality to the Congress, Italy, it would appear, twice, England once. The question was finally decided by a regular division, after the manner of the German Reichstag, when 294 members voted for Rome and 274 for London.

The sectional proceedings were conducted on the lines of the German Naturforscher-Versammlung. The presidents of the eleven sections and four subsections were almost all Berlin men. Their names

are:—(1) Analytical chemistry, G. von Knorre; (2) inorganic chemical products, A. Heinecke, director of the Berlin porcelain manufacture; (3*a*) mining and metallurgy, G. Weeren; (3*b*) explosives, W. Will; (4*a*) organic products (including tar), H. Wichelhaus; (4*b*) dyes, A. Lehne; (5) sugar, A. Herzfeld; (6) fermentation and starch, M. Delbrück; (7) agricultural chemistry, O. Kellner; (8) Hygiene, E. A. Merck; subsections (*a*) foods, K. von Buchka; (*b*) pharmacy, H. Thoms; (*c*) hygiene, M. Rubner; (9) photochemistry, A. Miethe; (10) electro- and physical chemistry, H. Böttinger (of Elberfeld); (11) legal and economical questions, C. A. von Martius. Before adjourning each day, the sections, however, nominated the president and vice-presidents for the following meeting. As a result, the time limits, twenty minutes for the reading of a paper, five minutes for each speaker, were not well adhered to. Each speaker is at once presented with a slip of paper on which he is to condense his remarks for publication in the daily journal or later in the reports. Some sections gave brief abstracts of the proceedings in the daily journals, others merely stated titles of papers and names of authors and speakers. A not inconsiderable number of the 457 reports and papers announced were not read owing to the—frequently only momentary—absence of the authors. Brief abstracts of some of the most important papers will follow.

H. BORNS.

NOTES.

THE annual conversazione, or ladies' soirée, of the Royal Society will be held on Friday, June 19.

PROF. J. J. THOMSON has had the honorary degree of doctor of science conferred upon him by the Columbia University, New York.

SIR OLIVER LODGE delivered the Romanes lecture in the Sheldonian Theatre, Oxford, on Friday last, on the subject of "Modern Views of Matter."

A GENERAL meeting of the Institution of Mining Engineers will be held in London on Thursday, July 2, and the following day in the rooms of the Geological Society.

MR. E. T. WHITTAKER, of Trinity College, Cambridge, will deliver an address before the Mathematical Society of University College, London, on Thursday, June 25, at 5.30 p.m., on "Some Present Aims and Prospects of Mathematical Research."

THE *Moniteur Officiel du Commerce* of Paris announces that an International Exhibition of the Industrial Appliances of Alcohol will be held at Rio de Janeiro in August.

A REUTER telegram from Cape Town states that the *Gauss* expedition has disproved the existence of Termination Island, which is marked on maps, the expedition passing over the alleged site of the island.

THAT the Soufrière in St. Vincent is still in a state of slight agitation is recorded by Dr. E. O. Hovey (*Sentry*, Kingstown, March 13). Outbursts issue from time to time from the centre of the lake in the crater. The most impressive changes which have taken place are in the erosion of the lately-erupted volcanic material, and he estimates that twenty-five million tons have been carried to sea from the valley of the Wallibou.

WE referred last week to the demonstration of the practical working of the Marconi long-distance wireless telegraphy given by Prof. Fleming during his lecture at the Royal Institution. Prof. Fleming has written to the *Times* complaining that the experiments were made particularly difficult to carry out towards the end of the lecture as the signals were being wilfully interfered with by an outside source. Mr. Nevil Maskelyne, in a reply to Prof. Fleming's letter, admits that he was the author of the interference, which was designed to demonstrate that the Marconi Company was not justified in its claim that it had solved the question of interference. A lecture at the Royal Institution scarcely seems a suitable occasion for settling commercial or semi-scientific disputes, nor can the result of the experiment be regarded as convincing. It shows, no doubt, that it is possible for an outsider to interrupt the signalling, but then it is also possible to throw stones at telegraph wires and break them; it does not demonstrate that two different systems working legitimately side by side would interfere with one another when the ordinary precautions necessary in commercial work were being taken.

LAST week telephonic communication was opened between London and Brussels. The line is particularly interesting, as the submarine portion forms the longest submarine telephone cable yet laid. The total length from St. Margaret's Bay (Dover) to La Panne, Belgium, is a little more than forty-seven miles; this is rather more than double the length of the Dover-Calais cable (twenty-three miles), which forms part of the London-Paris telephone line. The cable was made by Henley's Telegraph Works, and was laid in three sections by the *Alert* and the *Monarch*, the two joints being made at sea. The *Alert* laid 16½ miles of cable, chiefly in the shallow water off the Belgian coast, the remaining 30½ miles being laid by the *Monarch*; the cable crosses one of the Anglo-Belgian telegraph cables in deep water at about one-third of the total distance from La Panne. The length of the whole line from London to Brussels is 210 miles, made up as follows:—83 miles overhead lines in England, 80 miles overhead lines in Belgium, and 47 miles submarine cable.

THE promoters of the mono-rail high speed electric railway between Liverpool and Manchester hope to be able to start the work of construction this summer. When the railway is completed, a service of trains running at 110 miles an hour will be started; this will reduce the time taken over the journey from Liverpool to Manchester from forty to twenty minutes. Those interested in the scheme regard it as being the prelude to a reorganisation of express railway service throughout the country, and believe that once the possibility of working at these high speeds has been clearly demonstrated, the railway companies will be induced to build special mono-rail tracks alongside their existing lines for express services. It is already rumoured that the Great Western Railway is considering the advisability of constructing such a track for an express service between Bristol and London. In connection with high speed traction on railways, the experiments to be carried out in Germany during the next few weeks will be watched with interest. All the leading locomotive builders and electrical firms have been invited to submit designs, and trials will be made on the lines between Hamburg, Hanover and Berlin; it is hoped to attain speeds of 90 to 100 miles an hour with safety.

MR. A. MEEK informs us that a full-grown male beluga (*Delphinapterus leucas*) came ashore at the mouth of the Tyne on June 10, and was captured by the salmon fishermen. It measured 14 feet 2 inches. The specimen has already been cut up by the purchasers, so that it was possible to see that the teeth numbered eight on each side of each jaw, or thirty-two altogether, and that there were

eleven ribs on each side. The skeleton is to be presented to the Hancock Museum or to the Durham College of Science. Mr. Meek states that, so far as he is aware, an example of this species has not before been caught south of the Forth.

THE establishment of an economic tripos in the University of Cambridge will mark an important step in the movement which it is to be hoped will ultimately break down the barrier at present existing between the university man and the man of business. The proposed tripos has been warmly approved by a number of leading representatives of the railway, ship-owning, financial, mercantile, and manufacturing interests, as well as by prominent members of the Government. The tripos as proposed will consist of two parts, of which the first is to be taken in the second year, and will not qualify for a degree except in conjunction with some other examination. The syllabus of the first part includes (1) an essay paper; (2) one paper on the existing British Constitution; (3) two papers on recent economic and general history; (4) three papers on the general principles of economics. The historical part leads up to part ii., where specialisation is encouraged. In both parts questions, not all of which are optional, may be set, including quotations from French or German writers, so that a knowledge of these languages is essential. Among the careers for which the proposed tripos will afford a valuable training are those of the country squire, the politician, the business man, and the administrator of charities. It is only by the study of the principles of economics and political science treated as exact sciences, but founded upon actual facts of business life, that our country can hold its own against the competition of other countries where these principles are so studied, and can thus maintain that supremacy which it was able to obtain under entirely different conditions by rule of thumb methods and by pure speculation.

THERE was little new in the narrative of the British Antarctic Expedition given by Sir Clements Markham at a special meeting of the Royal Geographical Society on June 10. Commander Scott's short record of the voyage of the *Discovery* and work of the expedition, brought back by the relief ship *Morning* at the end of last March, and printed in NATURE of April 2 (vol. lvii. p. 516), contained the substance of what has been achieved. Some of the results of explorations were summarised in a subsequent number (p. 12). The paper read by Sir Clements Markham confirmed the information given in these two messages. The description and discussion of the scientific results are left until Commander Scott and his fellow-explorers return to this country with details of their work. In proceeding along the ice-barrier, the furthest easterly point reached was 152° 30′ W., and at this extremity extensive land, to which the name King Edward VII. land has been given, was found, rising to heights of 2000 to 3000 feet. The ice-barrier was studied from this point to Cape Crozier, and its height was found to vary from 30 to 900 feet. The winter quarters of the ship were in lat. 77° 50′ S., which is more than 500 miles further south than any ship has wintered before. Meteorological observations made in this position over a period of two years will be of great value. The most southerly point reached by a sledge journey from the ship was lat. 82° 17′ S., long. 163° E., and from it a range of mountains was seen extending as far as visible in a south by east direction. The journey during which these observations were made occupied ninety-four days, and the explorers must have travelled more than 980 statute miles. Another journey was made to the west of the ship, the farthest point reached being in lat. 77° 21′ S., long. 157° 25′ E. The horizon to the west of this point was unbroken and clear. An altitude of 9000 feet was attained at a distance of 142 miles from the ship as the crow flies. Many interesting photographs were shown at the meeting, and judging from them and the brief messages brought back by the *Morning*, the expedition will contribute much to our knowledge of the physical and biological conditions of South Polar regions.

A SHORT account of one of the sections of the International Congress of History was given in NATURE of April 30 (vol. lxvii. p. 613). A memoir by Prof. Ernest Lebon, describing a plan for an analytical bibliography of contemporary works on the history of astronomy, was among the papers presented to the congress, and has since been laid before the Paris Academy of Sciences. At the meeting of the Academy at which the memoir was received, M. Paul Appell, Dean of the Faculty of Sciences of the University of Paris, spoke in favour of Prof. Lebon's plan, and said that the bibliography would not only be valuable to scientific historians, but would also be welcomed by all astronomers. The May number of the *Bulletin de la Société astronomique de France* contains the titles of the chapters of Prof. Lebon's work, and the names of the authors of books and papers which are summarised in it.

DURING a heavy thunderstorm at Heppner, Oregon, on Sunday last, a remarkable downpour of rain occurred, producing a destructive flood, which caused the death of more than three hundred people. Heppner is situated in a gulch through which a stream runs usually only a few feet in width. On Sunday a dense cloud suddenly covered the mountain overlooking the town, and the rain which followed produced a great mass of water which rushed down the mountain and carried everything before it, the little stream being quickly converted into a deep torrent about four hundred feet wide. The flood swept a clean path more than a mile long and two blocks wide through the town.

THE daily weather report issued by the Meteorological Office on Saturday morning, June 13, showed that the area of high barometric pressure lying outside our Atlantic coasts had to some extent given place to a disturbance of a very complex character which occupied the whole of England. By about midday heavy rain set in over a great part of the country, and continued persistently, especially over the southern districts, during the following days. In the neighbourhood of the metropolis rain continued with scarcely any intermission for a period of 59 hours, and the amount measured in the week was 4·82 inches, being nearly 3 inches in excess of the average for the month. In the north of London the fall was even heavier than in the south, and amounted to about 2¼ inches in the 24 hours ending 8h. a.m. on Monday, while the temperature, owing to the continuation of northerly winds, was about 20° below the average. To find such a heavy fall of rain in June we have to go back to 1860, when an amount of 5·8 inches was measured at Greenwich, but this was spread over twenty-three days. The average rainfall for the neighbourhood of London is 1·93 inches only for the month of June. The heavy rainfall was entirely due to the lingering of the low barometric pressure to the southward.

IN the *Quarterly Journal* of the Royal Meteorological Society for April last, Mr. W. Marriott contributed an interesting paper on the earliest *telegraphic* daily meteorological reports and weather maps. The paper refers specially to reports relating to this country, although mention is made of the maps compiled in the United States

by the Smithsonian Institution by means of telegraphic reports, in 1849, and some years previously, from monthly returns, by Prof. Espy. The first telegraphic weather report in this country appears to be that published by the *Daily News* on August 31, 1848. The first printed daily weather map was that issued in August, 1851, at the great exhibition in Hyde Park. The first Government daily weather report was prepared by Admiral FitzRoy, and issued to London newspapers in 1860. In January, 1871, the *Shipping and Mercantile Gazette* published daily wind charts, prepared by the Meteorological Office, and in March, 1872, that office issued its first daily weather maps. The 6h. p.m. weather maps published by the *Times*, and prepared by the Meteorological Office, commenced on April 1, 1875. As Mr. Marriott has also quoted the weather maps prepared by Mr. Glaisher from July, 1849, which do not appear to have been entirely based on telegraphic reports, we may direct attention to one or two early English investigations of a somewhat similar nature. In the report of the Meteorological Department of the Board of Trade for the year 1857, Admiral FitzRoy directed attention to the desirability of collecting synchronous weather observations, and subsequently some hundreds of synchronous charts were prepared in the office, although not published, excepting for the time of the "Royal Charter" storm (October, 1859). Mr. Francis Galton discussed the daily weather for the month of December, 1861, and some 600 maps and diagrams were published in "Meteorographica" (Macmillan, 1862). With respect to work abroad, it may not be out of place to state that between 1816–20 H. W. Brandes apparently prepared synchronous weather charts for each day of the year 1783, from the Mannheim and other observations. Although the charts were not published, the data on which they were constructed were quoted in his "Beiträge zur Witterungskunde" (Leipzig, 1820), and one of the maps (for March 6, 1783) was reconstructed and published in "Les Bases de la Météorologie dynamique," by Dr. Hildebrandsson and M. Teisserenc de Bort (Paris, 1898).

AT the recent flower show held in the Temple grounds, amongst the hardy shrubs there was displayed a profusion of maples, many of which hail from Japan. An interesting article on these and other Japanese trees which commend themselves by reason of their quick growth and free flowering habit is contributed by Mr. J. H. Veitch to the last number of the *Journal* of the Royal Horticultural Society. Amongst the more technical contributions to be found in the same publication, one of considerable importance is the account of manurial experiments with vegetable crops carried out by Dr. Dyer and Mr. Shrivell.

IN the absence of the director, the annual report for 1902 of the Royal Botanic Gardens, Ceylon, has been issued by the assistant director, Mr. J. B. Carruthers. During the year an estate of 500 acres was acquired with the object of turning it into an agricultural experiment station, and was placed under the charge of Mr. H. Wright. The value of a special establishment for dealing with agricultural matters of economic importance is evident, and the presence of aggravated canker amongst the cacao trees growing on the land acquired for the purpose provided an opportunity for demonstrating the scientific treatment of this disease. In the ornamental lake of the Peradeniya Gardens an artificial island was constructed of mud taken from a depth of 8 to 10 feet below the water. It is expected that an instructive object lesson in the seed dispersal of terrestrial plants will be afforded by the systematic examination of the plants which develop on this area. A first attempt to raise worms and silk cocoons in the island is recorded by Mr. E. E. Green. In spite of untoward circumstances, of which the principal was a shortage of mulberry leaves or any other efficient substitute, the few cocoons raised were quite satisfactory, and it seems probable that the industry might with advantage be taken up by the natives.

DR. HÄCKER, whose investigations on the cytology of Copepods are well known, has recently (*Jen. Zeitschr, f. Naturw.* 1902) reinvestigated the question as to the permanence of the maternal and paternal chromosomes in the germ cells of the offspring. The result has been not only to show that the parental chromosomes remain distinct in the nuclei of the germ tract of the young organisms, but that the processes associated with the "reduction-divisions" may prove to be even more complicated than had previously been supposed. It appears that in the early prophase of the heterotype mitosis, tetrads are formed in numbers equal to those of the *somatic* chromosomes. These are divided, during the first polar mitosis, by an "equal" division, twelve dyads travelling to the respective poles. These the dyads fuse longitudinally in pairs, thus giving rise to the reduced number (6) of chromosomes. The next mitosis divides these in such a way that the collaterally fused pairs are transversely split, and thus a true qualitative "reduction division" is brought about. It would thus appear that the first of the two divisions effects the mingling of the parental chromosomes, whilst the second ensures a qualitative distribution of those originating from the *penultimate* (grandparent) generation. This occurs in such a way that each of the six chromosomes ultimately passing to the daughter-nuclei consists of halves contributed by two different grandparents.

WE have received the report (Aarsberetning) of the Bergen Museum for 1902.

NO. xi. of the *Sitzungsberichte* of the Vienna Academy for the current year contains a *résumé* of the results of Dr. F. Steindachner's recent expedition to Brazil.

THE "dragonets" (Callionymidæ) and allied fishes of Japan are described by Messrs. Jordan and Fowler in No. 1305 of the *Proceedings* of the U.S. Nat. Museum, several new forms being recorded.

AMONG the contents of the June number of the *Entomologist* we find a paper on the parasitic Hymenoptera and Tenthredinidæ collected by Mr. Whymper in the Andes of Ecuador, and a continuation of Miss Sharpe's list of butterflies from British East Africa.

THE *Proceedings* of the South London Entomological and Natural History Society for 1902 is illustrated by two plates, devoted to the life-history of the crustacean *Argulus foliaceus*, which lives parasitically on sticklebacks. The council reports that the affairs of the Society continue to prosper, the number of members again showing a slight increase.

A REVISION of the American moths of the family Gelechiidæ, with descriptions of new species, by Mr. A. Busck, of the Department of Agriculture, appears in vol. xxv. (No. 1304) of the *Proceedings* of the U.S. Nat. Museum. No. 52 of the *Bulletin* of the U.S. Nat. Museum, comprising 723 pp., is devoted to a list of North American Lepidoptera, which will doubtless prove of great value to entomologists.

IN their thirty-first annual report (for 1902) the directors of the Zoological Society of Philadelphia record a general satisfactory progress on the part of that institution. With the exception of a slight diminution, probably due to un-

favourable weather, during three months, the number of admissions to the gardens shows a steady increase throughout the year. A number of species of animals have been exhibited for the first time in the menagerie during the year.

"SAWDUST AND FISH LIFE" is the title of an article in a recent issue of the *Transactions* of the Canadian Institute. From the result of experiments in aquariums, the author, Dr. A. P. Knight, gives reasons for the belief that the sawdust thrown in large quantities into the Canadian rivers is very harmful to fish; but from actual observations in the rivers themselves, it does not appear that the destruction is as great as might have been expected.

WE have received a copy of an "Outline of Special Course in Natural History for Training Colleges and King's Students," just issued by the Marischal College, Aberdeen. It contains outlines for demonstrations on classification, the adaptation of animals to their surroundings, and examples of the leading types of animal life, concluding with suggestions for seasonal studies in natural history. Although the illustrations are somewhat crude, the pamphlet seems well adapted to its purpose.

THE Liverpool Marine Biology Committee is to be congratulated on the issue of the tenth fasciculus of the well-known "L.M.B.C. Memoirs," this part, of which Prof. J. R. A. Davis and Mr. H. J. Fleure are the joint editors, being devoted to the common limpet (Patella). The mode of treatment of the subject follows the line of the earlier issues, and the illustrations are numerous. The authors believe that, although limpets are rightly included among the lower gastropods, yet that they form an isolated type, which has been specialised in connection with their adoption of the habit of adhering to exposed surfaces, and making limited excursions for the purpose of feeding.

THE report on the examination of food, drugs and public water supplies reviewing the work of the Laboratory of Hygiene of the State of New Jersey, U.S.A., has reached us. It deals especially with the analytical methods employed in testing foods and drugs; these are detailed, and should be of considerable service to public analysts in this country.

WE have received the "Year Book" of the Livingstone College. The College trains missionaries in the elements of medicine and hygiene, the curriculum extending over a period of nine months. During this time the students are systematically trained in the elements of anatomy and in hygiene, nursing, cooking, &c., suitable to tropical climates, as well as in the prevention and treatment of the ailments they are likely to meet.

A COPY of the report of the Medical Officer of Health for the City of London for 1902 has been received. It contains an account of the procedures adopted by the Corporation of London for the sanitary protection of its citizens, some of which have already been noticed in these columns, *e.g.* the prohibition of spitting, and condemnation of typhoid-contaminated shell-fish. A point of interest is that, though the *day* population of the City probably exceeds 359,000, only 339 births were registered during 1902.

THE geology of the country near Leicester is the title of a memoir, by Mr. C. Fox-Strangways, lately issued by the Geological Survey. It is accompanied by a colour-printed map of the area, which includes Mount Sorrel and Leicester on the west, and parts of Rutlandshire on the east. Excepting for the granite quarries at Mount Sorrel, numerous brick-yards, sand and gravel pits, and occasional lime-works, the country is essentially one of meadow and pasture, and a famous hunting ground, the subsoil being for the most part clay—Boulder-clay, Lias-clay, Keuper Marl, and Alluvium. As most of the area is drift-covered, this new map differs very largely from the old series geological survey map, on which only the "solid" geology was depicted. In addition this new map has alongside it a colour-printed section which gives an excellent and instructive view of the structure of the ground. In the memoir Mr. Strangways gives full particulars of the strata, a catalogue of the fossils from the Trias and Lias of Leicestershire and Rutland, and numerous records of borings and well-sections. A photographic plate shows the weathered crags of granite at Mount Sorrel, grooved by the erosive power of wind-drifted sand in Triassic times, as pointed out by Prof. Watts. The price of the memoir is 3*s.*, and of the map 1*s.* 6*d.*

A "Subject List of Works on Architecture and Building Construction, in the Library of the Patent Office," has been published in the Patent Office library series. The subject list consists of two parts, viz. a general alphabet of subject headings, with entries in chronological order of the works arranged under these headings; and a key or summary of these headings shown in class order. Copies of the publication can be obtained at the Patent Office, Chancery Lane, W.C., price sixpence.

A SECOND revised edition of the "Smithsonian Physical Tables," prepared by Prof. Thomas Gray, has been published by the Smithsonian Institution. This edition differs from that issued in 1897 in a few particulars only, the chief alteration being that the table of electrochemical equivalents now contains columns showing atomic weights with O=16 and H=1 based upon the report of the International Committee on Atomic Weights. The table giving values of the density and volume of water between $-10°$ C. and $100°$ C. needs revision, the volumes from $46°$ to $100°$ being obviously wrong in the second decimal place. This, however, is a small point, and can be easily corrected by anyone using the tables. By issuing works of this kind, which are very valuable to teachers and investigators, but for which the demand is necessarily limited, the Smithsonian Institution is doing great service to science.

THE first number of the "Year Book" of the Carnegie Institution of Washington contains detailed information of what has already been accomplished for the encouragement of scientific research as the result of the munificence of Mr. Carnegie. Upwards of 38,000*l.* has been voted to assist a number of men of science in their investigations, but the fund, large as it is, has proved inadequate to meet all the requests for aid received by the trustees. As a consequence it has been found necessary to limit the activities of the institution—ground already occupied will be avoided, the systematic education of students will not be undertaken, and sites and buildings for other institutions will not be provided. It is to be understood, the "Year Book" states, that apparatus and materials purchased to assist investigators are to be regarded as the property of the Carnegie Institution. The persons assisted are expected to report upon the methods followed and the results obtained, and to state in the published results that aid was received from the Institution. Appropriations are to be made from time to time for the printing of papers of acknowledged importance To secure the counsel of experts, special advisers have been, and will be, invited from time to time for consultation. The first appendix, which runs to 238 pages of the "Year Book," consists of reports of eighteen advisory committees on the chief branches of scientific

knowledge. Another appendix deals with the proposed explorations and investigations on a large scale, and is contributed to by several well-known American men of science.

A STRIKING illustration of the enormous advance that has taken place in chemical manipulation during the past two or three years is afforded by a paper, in a recent number of the *Berichte*, on the "Evaporation and Boiling of Metals in Quartz-glass and in the Electric Furnace in the Vacuum of the Kathode-light." Dr. F. Krafft there states that the quartz tubes could be safely heated to 1200°, and with care up to 1400° C., even when exhausted to the low pressure required for the production of the kathode-light in a vacuum tube, and that even when containing metals they could be safely taken from the furnace at 1200°, allowed to cool in the air without annealing, and then replaced in the furnace without any risk of fracture. By using an electric furnace it was possible not only to regulate the temperature within 2° or 3° between 18° and 1400° C., but also to connect the quartz tubes to the pump by means of a ground-glass joint made tight with wax, the wax remaining unmelted although within a few inches of the hottest part of the furnace.

THE results achieved by the methods described in the foregoing note were remarkable. The only vapour in the quartz tube was that of the metal, which extended from the surface of the liquid to the top of the furnace, above which condensation took place. Under this almost inconceivably low pressure cadmium boiled at 420°, *i.e.* below the boiling point of sulphur, zinc at 545°, and bismuth below 1000°, the temperature of the furnace being about 150° above that of the boiling metal. Lead could be rapidly distilled with a furnace temperature of 1180°, and antimony at 775–780°. Silver began to evaporate fairly rapidly at 1200°, but did not boil at 1340°; copper showed a distinct, though slight, evaporation at 1315°, but gold, even at 1375°, the highest temperature reached in the experiments, gave only a small mirror of silver, and below it a tiny distillate of gold weighing less than 2 mg. It is of interest to note that the boiling points in an absolute vacuum of these metals, which probably lie at about 1400°, 1600°, and 1800° respectively, are in the order of increasing valency, and not in the order of their atomic weights.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*), a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. C. S. Birch; a Two-spotted Paradoxure (*Nandinia binotata*), two Senegal Touracous (*Turacus persa*) from West Africa, presented by Mr. James Drew; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by the Hon. Sibyl Edwards; a Patagonian Cavy (*Dolichotis patachonica*) from Patagonia, presented by Sir E. G. Loder; a Common Quail (*Coturnix communis*), British, presented by Mr. J. Woodward; an Adanson's Sternothere (*Sternothoerus adansoni*) from West Africa, a Pale Lizard (*Agama pallida*), an Egyptian Eryx (*Eryx jaculus*), a Blunt-nosed Snake (*Tarbophis obtusus*), a Schokari Sand Snake (*Psammophis schokari*), a Diademed Sand Snake (*Lytohynchus diadema*) from North Africa, presented by Captain Stanley Flower; a Stair's Monkey (*Cercopithecus stairsi*) from British East Africa, a Green Monkey (*Cercopithecus callitrichus*), an Eroded Cinixys (*Cinixys erosa*) from West Africa, a Black-headed Lemur (*Lemur brunneus*), a Grey Lemur (*Hapalemur griseus*) from Madagascar, five Grey Monitors (*Varanus griseus*), five Spiny-tailed Mastigures (*Uromastix acanthinurus*), eight Ocellated Sand Skinks, a Corais Snake (*Coluber corais*) from South America, a King Snake (*Coronella getula*), a Mocassin Snake (*Tropidonotus fasciatus*) from North America, a Carpet Python (*Python variegata*) from Queensland, a Rhesus Monkey (*Macacus rhesus*, var.), two Indian Rat Snakes (*Zamenis mucosa*) from India, deposited; a Burrhel Wild Sheep (*Ovis burrhel*), an Axis Deer (*Cervus axis*), born in the Gardens.

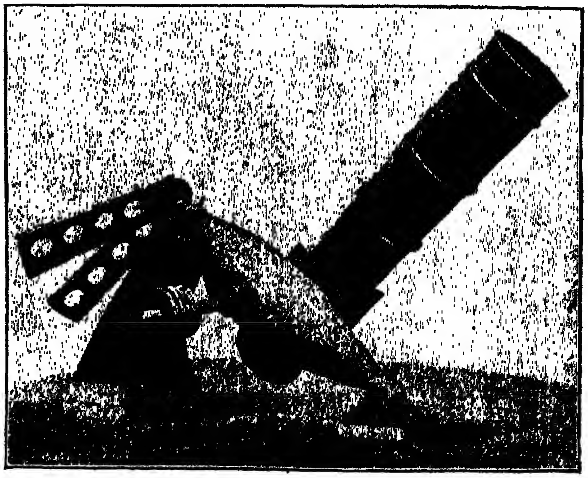
OUR ASTRONOMICAL COLUMN.

CONNECTION BETWEEN SUN-SPOTS AND ATMOSPHERIC TEMPERATURE.—M. Charles Nordmann has recently completed a discussion of the effect of sun-spots on the mean annual temperature of the earth's atmosphere in tropical regions. The period under discussion extends from 1870 to 1900, and the method of discussion is analogous to that published by Köppen in 1873, which dealt with the period 1830 to 1870.

M. Nordmann has compared the mean annual variations of temperature from the normal, as obtained from the observations made at thirteen tropical stations situated in various longitudes, with Wolf's numbers for sun-spot frequencies during the same period, and from the two curves obtained by plotting the two sets of numbers he has arrived at the following conclusion:—"The mean terrestrial temperature follows a period sensibly equal to that of solar spots; the effect of spots is to diminish the mean temperature, *i.e.* the curve which represents the variations of temperature is parallel to the inverse curve of sun-spot frequencies (*Comptes rendus*, No. 18).

THE CROSSLEY REFLECTOR OF THE LICK OBSERVATORY.—This reflector, it will be remembered, was presented to the Lick Observatory by Mr. Crossley, of Halifax, Yorks, and contains one of the splendid mirrors made by the late Dr. Common. It has an aperture of 3 feet, and a focal length of 17 feet 6 inches. When remounted and used at Lick it was found that the instrument was unsuitable for long exposures on account of flexure and other defects, therefore a new mounting has been devised and constructed by Messrs. Harron, Rickard and McCune, of San Francisco, and is found to work satisfactorily.

The polar axis is 14 feet long, and is so raised as to allow the instrument to be used in all positions. As shown in the accompanying illustration, this axis rests on two piers, the northern one consisting of an inclined steel



pillar, 8 feet high, resting on a concrete and brick foundation which is 6 feet high, whilst the bearing for the southern end, carrying the altitude and azimuth adjustments, rests directly on the brick and concrete foundation, the downward thrust being borne by hardened steel balls. The telescope tube is carried by the strong steel declination axis, and the mirror is contained by a cast-iron cell in the lower cylindrical section of the steel tube, whilst the photographic plate holder, with the usual adjustments, is placed

at the focus of the mirror and in the optical axis of the same.

The driving motion of the clock is transmitted to the telescope by two sectors, one of which is being run back ready to be put into gear again whilst the other is being used; each sector allows of one hour's exposure being made. The "following" is performed by means of an auxiliary telescope rigidly attached to the plate holder (*Scientific American*, May 16).

THE RELATIONSHIPS BETWEEN ARC AND SPARK SPECTRA.—In No. 4, vol. xvii. of the *Astrophysical Journal* there appears an advance translation, by the author, of a paper on the above subject recently communicated to the K. Akademie der Wiss. zu Berlin by Prof. J. Hartmann.

In his experiments on the arc spectrum of magnesium, using metallic poles, he found that the line at λ 4481, which is generally regarded as essentially a "spark" line, appears in the arc spectrum, and actually increases in intensity as the current strength becomes *less*: this is plainly shown in a table which accompanies the paper. From this and similar results the author arrives at the conclusion that the *higher* temperature of the spark, as compared with that of the arc, is open to question.

Further experiments showed that a high voltage was not necessary for the production of "spark" lines in the arc, for when a current of 20 volts and 4 amperes was used the line 4481 was about thirty times more intense than when 120 volts and 4 amperes were used.

Prof. Hartmann arrives at the conclusion that the energy of the electric discharge and of the chemical changes may play a more important part in the production of "spark" lines than temperature does, and in his experiments, in which the arc was formed in an atmosphere of hydrogen, he has shown that the dielectric is also an important factor in determining the nature of the spectrum obtained.

RADIO-ACTIVE PROCESSES.[1]

THERE are three distinct types of radiation spontaneously emitted from radio-active bodies, which may be called the α, β, and γ rays. The α-rays are prominent in causing the conductivity of a gas, they are easily absorbed by metals, and are projected bodies, not waves. These bodies are about the size of a hydrogen atom, they are positively charged, and travel with about one-tenth of the velocity of light. The β-rays are similar in all respects to the kathode rays produced in a vacuum-tube. The γ-rays are probably like Röntgen rays, but of very great penetrating power. The α-rays are by far the most important. In addition to these rays two of the radio-elements give off radio-active "emanations," which are in all respects like gases. The radiations from these emanations are not permanent, but fall off in a geometrical progression with the time. The radiation of the thorium emanation falls to half value in one minute, that from radium in four days. They have all the properties of gaseous matter in infinitesimal quantity. Their coefficients of diffusion can be measured, the order of their molecular weights is 100, they are occluded by solid compounds producing them, and may be condensed at low temperatures. The radium emanation condenses sharply at $-150°$ C., the thorium emanation between $-120°$ C. and $-150°$ C. The two emanations excite on objects with which they come in contact two kinds of temporary radio-activity, that from the radium emanation decaying much faster than that from the thorium emanation. The latter decays in a G.P. with the time falling to half value in eleven hours. These effects appear to be produced by solid matter in invisible and unweighable quantity, which can be dissolved off in some acids but not in others. On evaporating the solutions, the radio-activity is obtained unchanged in the residue. The experiments of Crookes and Becquerel in separating by chemical treatment the matter responsible for the activity of uranium, called uranium X, were referred to, together with the latter's observation that the separated activity had completely decayed after the lapse of a year, by which time the uranium itself had completely recovered its activity. The work of Rutherford and Soddy on thorium was then discussed in detail. Thorium precipitated in solution by ammonia retains only 25 per cent. of its activity. If the solution is evaporated and ignited the remaining 75 per cent. is found in the extremely small residue left, which by reason of its separation is different chemically from thorium, and was called thorium X. Left to themselves, the thorium gradually recovers its activity, and the ThX loses it. The activity of the latter falls in a G.P. with the time, the half value being reached after four days. At any time the sum total of the two activities is a constant. This would occur if the ThX were being continually produced by the thorium, and this was shown to be the case by precipitating thorium at definite intervals after its separation from ThX. The ThX, and not thorium, produces the thorium emanation. The production of ThX by thorium, of the emanation by ThX, and of the matter causing the excited activity by the emanation, are all changes of the same type, although the rates of change are distinct in each case. The change of uranium into uranium X is also similar, being the slowest of all. Twenty-two days elapse before uranium freed from ThX recovers one-half of its activity. In radium the radium emanation is the first product produced, and since this in a solid is almost completely occluded, the activity of a radium salt after it has been obtained from its solution rises after precipitation to several times its original value, due to the occlusion of the emanation. In all three radio-elements a part of the radio-activity is non-separable, and this part consists only of α-rays. The β-rays only result at the last stages of the process that can be experimentally traced. In all cases the radiation, from any type of active matter, is a measure of the amount of the next type produced. Thus the radio-activity of ThX at any period throughout its life is always a measure of the amount of emanation it produces. These results find their explanation if it is supposed that the α-particles projected form integral portions of the atom of the radio-active element. Thus ThX is thorium minus one or more projected α-particles. The emanation similarly is ThX less a further α-particle, and so on. The non-separable activity is due to the atoms of the original radio-element disintegrating at a constant rate. The whole of the processes take place unaltered in velocity, apparently under all conditions of temperature, state of aggregation, and chemical combination. This is to be expected of a subatomic change in which one system only is involved at each change. On this view the spontaneous heat-emission of solid radium salts, discovered by Curie, is explained by the internal bombardment by the α-particles shot off and absorbed in the mass of the substance. The amount of energy given out in these subatomic changes is enormous, and from Curie's experiments it can be deduced that each gram of radium gives out 10^9 gram-calories during its life, which is sufficient to raise 500 tons a mile high. It seems probable that the internal energy of atoms in general is of a similar high order of magnitude.

[1] Abstract of paper read before the Physical Society on June 5, by Prof. E. Rutherford, F.R.S.

SOME UNSOLVED PROBLEMS IN ENGINEERING.[1]

THE present lecture is devoted to the indication of some of the directions in which the further aid of the physicist is more immediately required by the engineer, while it is hoped that in future lectures each branch of inquiry thus pointed out will be dealt with in detail by someone who has made that particular subject his special study.

In view of the great interests—monetary and otherwise—involved, it appears to me that the whole question of steam-jacketing, and particularly the application of such jackets to compound or multiple-expansion engines of modern types and of large power, using steam at high pressures, deserves a much more thorough and systematic investigation than it has hitherto received.

The action of steam-jackets is, however, only one of several important problems relating to steam-engine economy at present remaining unsolved. Another is the

[1] Abridged from the eleventh "James Forrest" lecture delivered by Mr. W. H. Maw to an Engineering Conference on June 16, at the Institution of Civil Engineers.

economic effect of interheaters, through which the steam is passed on its way from one cylinder to another, of a compound or triple-expansion engine. During the past half-century, numerous types of interheaters have been designed and applied more or less spasmodically; while, in recent years, the use of such appliances has become a prominent feature in certain branches of American practice. The data on which the use of such heaters is founded, however, are far from being of a satisfying character, and they present discrepancies which certainly require clearing up.

What is really required is accurate information as to the extent to which our most advanced steam-engine practice can—especially in the case of large power units—be improved by the use of superheated steam, and as to the manner in which such improvement can best be realised. In connection with this matter, I may point out that we are much in want of a thorough determination of the physical properties of superheated steam, extending over the range of temperatures and pressures likely to be employed in practice. Such a determination may, I hope, soon be undertaken. Equally desirable also is the thorough investigation of the action of steam—both saturated and superheated—in the various types of turbine motors, a matter which has, as yet, been by no means dealt with so exhaustively as its great, and rapidly growing, practical importance deserves, and respecting which many lessons undoubtedly remain to be learnt.

In addition to the various points already mentioned, the question of the economy to be secured by the use of still higher pressures of steam than are now used requires investigation. We are without any direct determination of the latent heat, volume, and temperature corresponding to pressure in the case of steam of pressures exceeding 350 lbs. per square inch. The published data relating to steam of higher pressures have been obtained by extrapolation, and are by no means strictly to be relied upon.

The thorough investigation of the theory and practical working of internal-combustion engines presents for solution problems at once so numerous and so varied as to tax to the utmost the skill and ingenuity of the experimenter. There appears to be good ground for believing that with an increase of temperature there is a very substantial increase in the specific heats of such gases. While, however, the general fact may be regarded as proved, the numerical data necessary to enable that conclusion to be turned to practical account are far from having been fixed with certainty, and further determinations are greatly wanted.

The value of experiments on internal-combustion engines depends in a most important degree upon the accuracy with which variations of temperature can be observed, both in the cylinder before and during explosion, and in the walls of the chamber in which the explosion occurs. As Prof. Callendar has pointed out, the temperature assumed by the platinum wire of an electric resistance thermometer exposed to such gases must necessarily be less than that of the gases themselves. Moreover, the rate at which heat is communicated from the gases to the wire is dependent not only upon the difference of temperature, but also on the pressure, in a way not yet accurately known; and thus the accurate determination of the results of explosions in internal-combustion engines means not merely the skilful use of known appliances, but the determination of certain physical constants involving much expenditure of time and labour. Then, again, the effect of the injection of water or water-vapour into the cylinder in itself offers much scope for investigation, as does also the influence of the quality and quantity of the lubricating oils on the gaseous mixture. The governing of internal-combustion engines and the regulation of the powers developed by them at various speeds and under varying conditions are also matters which present many unsolved problems.

In the case of large bridges, roofs, and structural work of that class, there is ample scope for aid to be given by the better determination of the amount and effect of wind-pressure—a branch of experimental inquiry which is at present far from being in a satisfactory state. What is greatly required is a thorough investigation of the action of the wind on surfaces of different areas and shapes, and particularly its effect on partially shielded areas. Amongst other points requiring settlement is the action of wind on the lee-side of roofs—a matter on which the experiments of Irminger have thrown much light, but which still requires further investigation.

In the determination of the stresses induced in the elements of a structure by the forces applied to that structure, there still remain many problems of importance imperfectly solved. The theory of the plate-web girder, for instance, is in a far from satisfactory state, particularly as regards the action of web stiffeners, the stresses on the web itself, and those on the connections between the web and the flanges. The whole subject of resistance to compound stresses—such, for instance, as those existing in the web of a plate girder or a flat stayed plate, forming part of a steam boiler—is one urgently requiring further experimental investigation.

Then, again, we are now largely using hollow shafts for marine and other purposes, and the relation of these to solid shafts of the same nominal strength, as regards the power of resisting repetitions of varying or alternating stress, has not yet been systematically investigated. Another point is the effect of oil-tempering and different modes of annealing on the endurance of fatigue, a matter which, in view of the effect of similar treatments on the ultimate strength and limit of elasticity of steel, is one of much importance.

The great problem we have still to face—and it is a problem which will tax to the utmost our powers of research—is the determination of what the change which we call elastic fatigue really is. The indications of ordinary testing machines do not reveal any change in the behaviour of a material which has certainly exhausted a large proportion of its "life" under repeated applications of stress, and we must evidently, to solve the problem, have recourse to other modes of inquiry. What is the change of structure produced by fatigue, and in the case of any but pure metals is this change accompanied by any rearrangement of the constituents? How is this change of structure affected by variations of treatments, by annealing, or, in the case of steel, by tempering?

It is sometimes of considerable importance to ascertain whether a certain object, as, for instance, a propeller shaft, or a portion of a bridge structure, or a steel rail, has or has not been injured by the repeated applications of stress to which it has been subjected; and at present the only method of determining this is the testing to destruction of the object respecting which the information is desired. But if we knew accurately in what part of the object the stresses to which it had been subjected would first cause injury, and if we further knew in what way the existence of such injury would be indicated by change of structure, it would follow that the microscopic examination of a small portion, cut from the most sensitive part of the object, would afford a valuable indication of what was going on.

There are other questions which appeal directly to the users of steel. Amongst such questions are the oil-tempering of mild steel forgings and of steel castings; the investigation of the treatment during manufacture and hardening of spring steel; the examination of the qualities of special steel alloys, suitable for the construction of engine or machine details, in which exceptional strength and lightness are essential; and the production of alloys capable of resisting corrosion and withstanding great changes of temperature, and thus specially suitable for the construction of superheaters and other apparatus in which such changes occur.

We have in new steels a series of materials which promise to revolutionise a very important percentage of our machine work, and to necessitate very material alterations in the proportions of our machine tools, involving very heavy outlay, if we wish to advance with the times. Now these are facts pointing to the necessity for extensive research conducted in a thoroughly systematic way.

I have endeavoured to show how desirable it is that the engineer and the physicist should work together in dealing with certain investigations which I have enumerated, and I have done so because, although engineers generally now fully appreciate the aid which physical science can afford, there has not hitherto been such an intimate association of the two classes of workers as is really desirable. But with electrical engineering the case is quite different. We are accustomed to speak of the extraordinarily rapid development of electrical engineering, and the marvellous way in which it is assuming such a paramount position in civilised life,

but I do not remember ever hearing this wonderful growth attributed to what I believe to be its real cause, namely, that from the moment that the practical application of electricity became one of the branches of our profession, engineers and physicists have worked closely hand in hand to overcome its difficulties, and to elucidate the questions to which it gives rise. The growth of electrical engineering thus constitutes a great object-lesson, sufficient in itself abundantly to emphasise the fact that the future progress of engineering is indissolubly bound up with the progress of physical research.

THE SOUTH AFRICAN ASSOCIATION.

REVIEWING the brief history of the events which culminated in the first annual meeting of the South African Association for the Advancement of Science, the early proceedings of which were described in our issue for May 21, Sir David Gill, the president, announced some of the facilities which had been offered to induce the British Association to visit South Africa in 1905. The president read a letter he had received from Sir Gordon Sprigg, the Prime Minister of Cape Colony, stating that free railway passes will be granted over the Cape Railway system for all officials of the British Association, and a limited number of invited guests; and that a sum not exceeding 6000*l.* will be guaranteed towards the cost of passages to and from the Cape for the above-mentioned officials and visitors. This amount will be shared by the Governments of the Transvaal, Natal and the Cape. Sir David Gill went on to say that the other Governments had undertaken to share one-half of this responsibility, and to grant similar free use of their railways. There will be no lack of private hospitality, and the council of the British Association will recommend to the general committee of the Association at the Southport meeting next September that the invitation to hold the annual meeting in 1905 in South Africa be accepted.

Reference was also made to the value of a closer alliance between the results of scientific research and everyday practice in commercial pursuits, the classical works of several of the earlier investigators being mentioned as examples of the far-reaching effects of thorough and precise researches into common everyday phenomena. Sir David Gill then proceeded to enlarge upon the practical value of scientific research, and the reasons for its encouragement in the universities and colleges, and mentioned the unselfish work of Profs. Beattie and Morrison in undertaking the magnetic survey of South Africa, during 1897 and subsequent years, entirely at their own cost. He strongly urged that facilities should now be granted to them for completing this most important work, which fills a gap in the observations that are now being carried out in various parts of the world simultaneously with those being made by the various Antarctic expeditions in the South Polar regions.

Two papers read before Section A of the South African Association contained interesting statistics as to different aspects of the mining industries of the new colonies. In a paper on "Nitro-Glycerine Explosives: their Influence on Industrial Development," Mr. William Cullen, of the Modderfontein Dynamite Factory, stated that by means of explosives alone above 12,000,000 tons of ore had been milled in the Transvaal in the year prior to the war, but no estimate could be formed of the many million additional tons removed in developing shaft-sinking and so on. The old dynamite is rapidly becoming a thing of the past, and the more modern blasting gelatin has gradually supplanted everything else. Perhaps the most interesting part of the paper was that where the final triumph of nitro-glycerine in cordite and many similar powders was demonstrated, proving it to be not only the strongest disruptive agent, but also the mildest and easiest managed impellent.

Mr. W. A. Caldecott, in a paper on the "Cyanide Process from its Introduction into the Rand to the Present Day," said the immense importance of the process was shown by the fact that just before the war half the gold from the Rand was obtained by the cyanide process. By way of comparison, the writer stated that the Rand gold output in 1890 was 494,523 ounces milled, and only 286 ounces obtained by cyanide process. In three years the proportion grew to 1,147,960 ounces milled, and 330,510 ounces by cyanidation.

The records of meteorological observations made at the dynamite factory of Modderfontein, which extend over a large number of years, and form probably the most complete Transvaal meteorological record available, were discussed by Mr. William Cullen in Section A. Rainfall, barometric pressure, temperature (maximum, minimum and average), atmospheric moisture, wind velocity and wind direction were some of the meteorological data passed in review. All were illustrated by diagrams. The rainfall for the various years was analysed, and it was pointed out where a departure from the normal had great influence on the agricultural interests of the Transvaal, and on the prevalence of cattle diseases. The average rainfall for the past five years was 25 inches, the highest being 30·6, and the lowest 20·1, and the observations seemed to show that it was on the increase. The barometric readings showed a very slight variation all through the year, the maximum difference of about 14 generally coming in June, but every twenty-four hours the maximum and the minimum records always occurred at the same time.

Prof. S. Schönland, in a paper to Section B on stone implements in the Albany Museum, emphasised the persistence of the Palæolithic age in South Africa as compared with other countries: While, he said, the manufacturers of stone implements in South Africa were not devoid of skill which must excite our admiration, while their arrow-heads of perforated stone, their rolling-pins, their stone rings, indicated that there was not only skill, but an inheritance of trade tricks handed down from generation to generation, which were faithfully adhered to by the masters of the craft, it was astonishing that so far it had been impossible to find any evidence of progress in the manufacture of stone implements in South Africa, such as we knew had taken place in other countries from Palæolithic times to the time when stone implements were given up. Generally speaking, it could be seen that not only had the Stone age persisted in South Africa until comparatively recent times, but that the Palæolithic age had persisted there to the same extent. This was especially shown in the entire absence of polished stone implements.

Dr. J. D. F. Gilchrist dealt in the same section with the development of some South African fishes. It has been commonly alleged that the practice of netting, as carried on in the Zwartkops, the Buffalo, and other tidal rivers of South Africa, has proved destructive to the eggs and spawn of fish. On the commencement of trawling by the Government steamer in False Bay and on the Agulhas Bank, it was urged that the dragging of the net along the bottom of the sea caused the destruction of great quantities of the eggs and young of food fishes. The evidence obtained by an inquiry held by a Parliamentary Commission seems to indicate that many of the common fishes may deposit their eggs on the bottom of the sea. On the other hand, in all the instances where the mature eggs had been procured and successfully fertilised on the Government steamer *Pieter Faure*, they were found to float on the surface of the water, and only after the larvæ had been hatched out some time did they begin to sink to the bottom. It was also brought to the notice of the Commission that it had already been demonstrated in northern waters that there was only one fish of practical economic importance depositing its eggs on the bottom—the herring—and only a small species of herring of little value to the present fishermen occurs in the Cape seas. Recently facilities have been afforded by Government for more careful examination on shore of the eggs and larvæ procured by means of fine nets and from the mature fish. The eggs and larvæ were described of the white stumpnose, red stumpnose, silver fish, sand fish, zeverrim or zee-basje, kabeljaauw, horse fish, red gurnard, klip-fish (two species), sole (two species), and the blaasop, and the ova and larvæ of fish as yet unknown. The general effect of the investigations so far carried out was to confirm that the trawling did not interfere with the eggs of fishes that were of practical commercial value.

At a concluding general meeting of the Association on the last day of the proceedings, the council of the Association for the present year was elected in accordance with nominations received from the chief centres in Cape Colony, Rhodesia, Transvaal, Natal, and Orange River Colony.

At a subsequent meeting of the newly-formed council, Sir Charles Metcalfe was unanimously elected president for the ensuing year and the 1904 meeting to be held at Johannesburg.

The following officers were also elected:—vice-presidents, Mr. Sidney J. Jennings, Dr. Muir, Mr. Gardner F. Williams, and Mr. J. Fletcher (Natal); hon. secretaries, Dr. Gilchrist (Cape Town), and Mr. Theodore Reunert (Johannesburg); hon. treasurer, Mr. W. Westhofen (Cape Town).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. Darwin and Prof. Larmor have informed the Vice-Chancellor that certain donors desire to contribute a sum of 400*l.* a year, for five years, for the purpose of augmenting the stipends of two university lecturers in mathematics. The object is to enable the lecturers, whose present stipend is 50*l.* a year each, to devote themselves by study and research to the advancement of mathematical science. The donors hope that by additional contributions a sum may be procured which will enable the arrangement to be continued, should it prove successful in the first instance. The general board recommends that the offer should be gratefully accepted, and it proposes that it should be authorised to appoint in October two lecturers in mathematics, who, for the sake of distinction, and to commemorate two of the most eminent of Cambridge mathematicians, shall bear the title of the Stokes lecturer and the Cayley lecturer respectively. The new offices are to be tenable with university and college lectureships.

The general board has been in communication with the council of the Royal Geographical Society respecting the reorganisation of geographical studies within the University. It suggests that a board of geographical studies should be appointed, on which the Society should have representatives; that this board should arrange courses of instruction and administer funds; and that a special examination in geography for the ordinary B.A. degree should be instituted. The council of the Society has agreed to contribute 200*l.* a year for five years, to be met by a corresponding grant from the University, for the expenses of the scheme, and it is hoped that other contributions to the geographical fund may be received. The tenure of the present reader in geography expires at Midsummer, but the general board has postponed making fresh arrangements until the Michaelmas term, when a complete scheme is promised.

The annual reports of the Botanic Garden Syndicate and of the antiquarian committee have been published in the *University Reporter* for June 13. They record a large number of gifts to the collections from many sources.

The professorship of surgery and the new lectureships in electrical and mechanical engineering were duly established by the Senate on June 11. An election to the former will be made during the summer. The latter will be held by Mr. Lamb and Mr. Peace, the present demonstrators of applied mechanics.

At the same congregation the grace which brings to an end the long reign of Euclid, as the sole arbiter of geometry in the pass examinations, was passed without a dissentient voice.

Dissertations and memoirs, constituting records of original research, and qualifying for the B.A. degree, have been approved in the case of Mr. J. C. Simpson, Caius (pathology), and of Messrs. R. K. McClung and J. J. E. Durack, Trinity, Mr. F. Horton, St. John's, and Mr. M. Varley, Emmanuel (physics).

In the mathematical tripos, part i., Messrs. Bateman and Marrack, Trinity, divide the senior wranglership. For the third place four candidates are bracketed, Messrs. Gold and Phillips, St. John's, and Messrs. Barnes and Hills, Trinity. Miss P. H. Hudson, Newnham, is bracketed seventh wrangler. She is the daughter of Prof. Hudson, of King's College, London, and the sister of the senior wrangler of 1898. Her sister was bracketed eighth wrangler in 1900. Six men and one woman obtain first classes in part ii. of the tripos. In the mechanical sciences tripos, part i., thirty men obtain honours.

THE department of psychology and education of the University of Colorado publishes from time to time booklets dealing with the investigations carried out by its staff. The most recently published number is concerned with certain aspects of educational progress, and includes five original articles dealing with subjects as different as the function of habits and the English Education Act, 1902. Under the title "Miscellanea" are given extracts from educational papers published in different parts of the world, and amongst them are two from NATURE.

AN instructive example of the close connection maintained between the needs of the American commercial community and the technical colleges of the United States is provided by a recent announcement from Chicago. In response to requests from insurance companies, architects, and contractors, the Armour Institute of Technology of Chicago is now offering a four years' course in fire protection engineering, leading to the degree of bachelor of science. This course will be inaugurated in September next under the direction of Prof. Fitzhugh Taylor, formerly engineer of the Underwriters' Laboratories. The requirements for admission are to be identical with those for the mechanical, electrical, civil, and chemical engineering courses. A special feature of the course will be a series of lectures by prominent insurance officials, architects, and contractors upon the practical features of their work. The technical laboratory work of this course will be given at the Underwriters' Laboratories of Chicago. These laboratories, maintained by the stock fire insurance companies, are well fitted for the work, because all new devices, appliances, and materials that enter into the question of fire protection, or have a bearing on fire risk, are taken there to be tested.

THE papers relating to the appointment and resignation of Mr. M. E. Sadler, Director of Special Inquiries and Reports on Education, have been published in a Blue-book (Cd. 1602). It is evident from the documents that Mr. Sadler was anxious to secure that education should have an open-minded and impartial intelligence office as much as the War Office or the Admiralty. With this object in view, and the desire to obtain increased efficiency, Mr. Sadler asked for increased facilities for his work, including "the creation of a new post of scientific assistant in the office of the Director of Special Inquiries and Reports of the Board of Education. The increase in the number of cases, referred to the office of Special Inquiries and Reports, in the consideration of which an expert knowledge of scientific terminology and a general acquaintance with scientific investigation and discovery are indispensable, renders it desirable that one of the officers attached to the staff of the Director of Special Inquiries should be specially charged with the duties of scientific assistant." This was in 1900, but objection was raised to the proposal by the vice-president. An inquiry into the nature of the demands was then asked for by Mr. Sadler, but was not approved. The result of this and other suggestions showed that there was no desire to develop the work of the Special Inquiries Office, but rather to limit it. Matters came to a climax early in this year, when a request for permission to prepare certain reports was made, but was met with objections. Subsequently, the Director framed a memorandum setting forth further needs of the Office of Special Inquiries, and stating that without additional assistance he could not continue to hold himself responsible for the collection and supply of accurate and well-digested information on educational work at home and abroad. The Board of Education failed to agree with the proposals made, and laid down certain new conditions for the conduct of the Special Inquiries Office. The result was that on May 9 Mr. Sadler wrote:—"The arrangements which have been proposed to me for the future conduct of the Special Inquiries Office would, in my judgment, gravely impair the scientific thoroughness and independence of the work of the office, and prove incompatible with future efficiency," and on this account he resigned his post.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 28.—"On the Theory of Refraction in Gases." By George W. **Walker**, M.A., A.R.C.Sc., Fellow of Trinity College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

The present theories of refraction in gases lead to the formula $\mu^2-1=Nf(p)$, where N is the number of molecules per unit volume, and $f(p)$ is a function of the frequencies of the waves and independent of temperature. The measured variation of μ with temperature does not agree with this formula. There are several cases where μ^2-1 is much less than $K-1$, where K is the dielectric constant, and in such cases we find that, although μ^2-1 is approximately proportional to N, $K-1$ is nearly proportional to N/θ, where θ is the absolute temperature.

The present theories are thus inadequate to explain the actual facts.

The view adopted in the present paper is that instead of having free periods of vibrations, the molecules move in constrained motion. Regarding the atom as consisting of a positively charged particle united with a large number of small negatively charged particles, it is supposed that the negative particles roll on the surface of the positive one, but do not vibrate radially. The control on transmitted waves is thus the rotational energy of motion of the particles, and it must be proportional to the absolute temperature.

When, by collisions or otherwise, the rotational motion becomes so great that the electric attraction is overcome by the centrifugal force, ionisation occurs. The frequency or frequencies of rotation at which this occurs are determined by the electrical attractions, and are independent of temperature, although, of course, the higher the temperature the greater will be the amount of ionisation. These frequencies are regarded as corresponding to the spectral lines; this view explains the ionisation produced by ultra-violet light, and also agrees with the fact that luminosity is probably always connected with ionisation, *e.g.* the characteristic lines come out in the electrical discharge through the gas.

Regarded simply as obstacles, the molecules must contribute a term to μ^2-1, which is proportional to N and practically independent of the frequency. The final formula obtained is

$$\mu^2-1=k_1N+k_2N/\theta\ f(p,\theta),$$

where k_1 and k_2 are constants, and $f(p,\theta)$ is a function of p and θ. The function is fully discussed in the paper.

The formula is shown to be capable of accounting for all the known facts connected with the dielectric constant and the refractive index, while the absorption of ultra-violet light and apparent absorption, due to selective reflection in the infra-red, is also explained.

Notwithstanding the very complex and varied facts in air, hydrogen, carbon dioxide, ammonia and sulphur dioxide, complete numerical agreement between the measurements of $K-1$ and μ^2-1, as regards both absolute magnitude and dependence on pressure, temperature and frequency, has been established.

Chemical Society, June 4.—Dr. W. H. Perkin, sen., F.R.S., vice-president, in the chair.—The following papers were read:—Formation of an anhydride of camphoryloxime, by Dr. **Lowry**. This anhydride is formed when nitrocamphor is boiled with concentrated hydrochloric acid.—Mutarotation of glucose, as influenced by acids, bases and salts, by Dr. **Lowry**. The mutarotation of glucose is greatly accelerated by the presence of alkalis, less so by acids, and is not influenced by the presence of salts.—The solubility of dynamic isomerides, by Dr. **Lowry**. It is shown that in some cases the determination of solubility may be applied to the study of dynamic isomerides, thus the solubility of *pseudo*-β-bromonitrocamphor in benzene at 10° increases from 2·3 to 9·3 per cent., whilst a mixture of this with its isomeride dissolves to the extent of 14 per cent.—The rusting of iron, by Dr. **Moody**. It is stated that the rusting of iron is brought about by the initial production of ferrous carbonate by the action of atmospheric carbon dioxide on the metal, this salt being subsequently oxidised. The non-production of rust in presence of agents which destroy hydrogen peroxide is regarded as due, not as Dunstan suggested, to the destruction of hydrogen peroxide, but to the insolubility of carbon dioxide in solutions of these substances. In the discussion it was pointed out that the presence of impurities in the iron or in the reagents employed would materially affect the production of rust by inducing electrolytic changes, and that Dunstan had already pointed out that carbon dioxide exercised an accelerating influence in the production of iron rust.—Iminoethers corresponding with ortho-substituted benzenoid amides, by G. D. **Lander** and F. T. **Jewson**. The authors find that they get better yields of iminoethers by alkylation in an ethereal solution than in an alcoholic one, but even there nitriles are formed. They also find that whilst *o*-toluamide gives a yield of only 13·6 per cent., *p*-toluamide gives 70 per cent. of iminoether.—The hydrolysis of ethyl mandelate by lipase, by H. D. **Dakin**. It is shown that *i*-ethyl mandelate is unequally hydrolysed by this enzyme, the product being *d*-mandelic acid.—Isomeric change in benzene derivatives. The conditions influencing the interchange of halogen and hydroxyl in benzene diazonium hydroxides, by Dr. **Orton**.—The synthesis of $\alpha\alpha\gamma$-trimethylglutaric acid and its derivatives, by Dr. W. H. **Perkin**, jun., and Miss A. E. **Smith**.—Hexamethyleneoctocarboxylic acid and the *cis*- and *trans*-modifications of hexamethylenetetracarboxylic acid, by Messrs. **Gregory** and **Perkin**.—The bases contained in Scottish shale oil, part ii., by Messrs. **Garrett** and **Smythe**.—A direct method for determining latent heat of evaporation, by Dr. J. Campbell **Brown**. The weight of liquid evaporated by a determinate amount of heat, applied at the boiling temperature of the substance, is determined in a special apparatus.—The four isomeric hydrindamine-*d*-chlorocamphorsulphonates and isomeric compounds of the type $NR_1R_2H_3$, by Dr. **Kipping**. The isolation of the isomeric hydrindamine salts referred to in the previous paper affords conclusive evidence of the occurrence of isomerism among quinquevalent nitrogen compounds of this type. The author accounts for this isomerism by the assumption that the five valencies of the nitrogen atom are directed from the centre to the angles of a square pyramid.

PARIS.

Academy of Sciences, June 8.—M. Albert Gaudry in the chair.—On a new general relation between electromotive forces of saline solutions, by M. **Berthelot**. If an element formed by two saline solutions separated by a porous partition A and B has an electromotive force E, the element A+AB, formed by the two solutions A and AB, with electromotive force ϵ_1, and the element B and AB, with electromotive force ϵ_2, then the relation $E=\epsilon_1+\epsilon_2$ is found to hold good. The relation concerning the union of acids and bases, established by earlier experimenters, is a corollary to this more general case.—The formation of alcohol in the fermentation of plant juices containing sugar, by M. Armand **Gautier**. An attempt to distinguish analytically between a naturally fermented wine and a liquid artificially fortified with alcohol. Attention was paid especially to the various forms in which nitrogen compounds were present; estimations of glycerol and acidity were also made. It was found that the best characteristics of a really fermented liquid were the amount of volatile acid and the complete absence of ammoniacal nitrogen.—On the propagation of waves in a perfectly elastic medium affected by finite deformations, by M. P. **Duhem**.—Prof. Lorentz was nominated a correspondant for the section of physics in the place of M. Amagat.—On the results obtained by cannonading against hail storms, by M. E. **Vidal**.—On the integrals of the equation $s=f(x, y, z, p, q)$, by M. E. **Goursat**.—On differential equations of the third order which admit of a continuous group of transformations, by M. A. **Boulanger**.—The motion of a solid in a gaseous medium, by M. L. **Jacob**.—An examination of the conditions which determine the sign and the magnitude of electrical osmosis and of electrification by contact, by M. Jean **Perrin**. Electrical osmosis is intense only for ionising liquids; thus a marked effect was produced with water, methyl, ethyl, and propyl alcohols, acetone and nitrobenzene, but was absent with benzene, ether and turpentine.—On the external thermal conductivity of silver wires plunged in water, by M. E. **Ragovsky**. The wires were heated electrically, and a steady current of water passed at a measured rate through the tube surrounding the wire, observations being made

when a stationary state was attained.—Hypothesis on the nature of radio-active bodies, by M. Fillipo **Re.** An extension of the nebular theory to the formation of atoms. It follows from the hypothesis that radio-active bodies should possess a high atomic weight, and should give out energy owing to the contraction of their atoms.—Dissociation curves, by M. A. **Bouzat.** From an examination of thirty-five experimental results the following law is deduced:—in a group of univariant systems in which a solid body gives rise by dissociation to another solid body and a gas, the ratio of the temperatures corresponding to a given dissociation pressure in any two systems of the group is constant, whatever the pressure may be. The law has been verified for a range of temperature from 238° to 1065° (absolute), and of pressures from 300mm. to 1600mm.—On the action of arsenic on copper, by M. Albert **Granger.** When copper is heated with arsenic in an inert gas at 440° for a sufficient length of time, a definite crystallised copper arsenide is produced, having the composition Cu_5As_2. Phosphorus gives a corresponding compound.—On the qualitative and quantitative analysis of osmiridium alloys, by MM. **Leidié** and **Quennessen.** The alloy is attacked by fused caustic soda and sodium peroxide, the osmium and ruthenium separated in the form of the volatile peroxides, and the iridium as the double nitrite of iridium and sodium.—On the nutrition of plants deprived of their cotyledons, by M. G. **André.** The assimilation of organic material is lessened by the removal of the cotyledons, but the ratio of phosphoric acid to nitrogen is practically unaffected.—On the mechanism of the saccharification of the mannanes of *corrozo* by the seminase of lucerne, by MM. Ed. **Bourquelot** and H. **Hérissey.** The extract from *Phytelephas macrocarpa* contains a soluble ferment the hydrolysing action of which is complementary to that of seminase.—Research on indoxyl in certain pathological urines, by M. Julius **Gnezda.**—The mechanism of the emission of larvæ in the female of the European lobster, by MM. **Fabre-Domergue** and E. **Biétrix.**—On the iron ore of Troïtsk, by MM. L. **Duparc** and L. **Mrazec.**—Castration in man, and the modifications which result from it, by M. Eug. **Pittard.**—On the kinematography of barometric movements, by M. P. **Garrigou-Lagrange.** A series of charts of isobars, mapped out for equal intervals of time, has been studied by means of the kinematograph. The examination of the American charts has clearly shown that, in spite of their apparent complication in detail, there are in reality but two general movements of the atmosphere. These two movements have the effect of alternately opening and closing the two routes followed by American depressions. A study of European charts leads to similar conclusions, although the regularity is less marked than in America.—On the conflagration of balloons during landing, by M. **de Fonvielle.** The disaster of the *Pannewitz* was probably caused by the electrification of the balloon giving rise to a spark.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part ii. for 1903, contains the following memoirs communicated to the Society:—

February 21.—E. **Riecke**: Contributions to the theory of atmospheric electricity, iii., on the mass of the ions contained in the air.

F. **Krüger**: The theory of polarisation-capacity.

March 7.—W. **Nernst**: The determination of molecular weights at very high temperatures.

F. **Bernstein**: On the associated domains (Hilbert's *Klassenkörper*) of an algebraical domain (*Zahlkörper*).

E. **Riecke**: Contributions to the theory of atmospheric electricity, iv., on the "adsorption" of ions at the earth's surface.

DIARY OF SOCIETIES.

THURSDAY, JUNE 18.

ROYAL SOCIETY, at 4.30.—(1) Surface Flow in Crystalline Solids under Mechanical Disturbance: (2) The Effects of Heat and of Solvents on Thin Films of Metal: G. Beilby.—The Forces Acting on a Charged Electric Condenser Moving through Space: Prof. Trouton, F.R.S., and H. R. Noble.—On the Discharge of Electricity from Hot Platinum: Dr. H. A. Wilson.—The Bionomics of *Convoluta Roscoffensis*, with Special Reference to its Green Cells: Dr. F. W. Gamble and F. W. Keeble.—New Investigations into the Reduction Phenomena of Animals and Plants; Preliminary Communication: Prof. J. B. Farmer, F.R.S., and J. E. S. Moore.—The Action of Choline, Neurine, Muscarine and Betaine on Isolated Nerve, and on the Excised Heart: Dr. A. D. Waller, F.R.S., and Miss S. C. M. Sowton.—The Physiological Action of Betaine Extracted from Raw Beet Sugar: Dr. A. D. Waller, F.R.S., and Dr. R. H. Aders Plimmer.—On the Physiological Action of the Poison of the Hydrophidæ; Part II. Action on the Circulatory, Respiratory and Nervous Systems: Dr. L. Rogers.—The Spectra of Neon, Krypton and Xenon: E. C. C. Baly.—And other Papers.

LINNEAN SOCIETY, at 8.—Descriptions of New Chinese Plants: S. T. Dunn.—On the Life-history of a New Indian Species of Monophlebus: E. P. Stebbing.—On the Anatomy of Leaves of British Grasses: L. Lewton-Brain.—Scottish Freshwater Plankton.

FRIDAY, JUNE 19.

ROYAL INSTITUTION, at 9.—Radium: Prof. Pierre Curie (in French).

MONDAY, JUNE 22.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Explorations in Bolivia: Dr. Evans.

WEDNESDAY, JUNE 24.

GEOLOGICAL SOCIETY, at 8.—On a Transported Mass of Ampthill Clay in the Boulder-clay at Biggleswade: Henry Home.—The Rhætic and Lower Lias of Sedbury Cliff, near Chepstow: L. Richardson.—Notes on the Lowest Beds of the Lower Lias at Sedbury Cliff: A. Vaughan.

THURSDAY, JUNE 25.

UNIVERSITY COLLEGE MATHEMATICAL SOCIETY, at 5.30.—Some Present Aims and Prospects of Mathematical Research: E. T. Whittaker.

FRIDAY, JUNE 26.

PHYSICAL SOCIETY, at 5. (University of London, South Kensington).—(1) Electrical Effects of Light upon Green Leaves; (2) Blaze-Currents, (*a*) of a Vegetable Tissue, (*b*) of an Animal Tissue; (3) Quantitative Estimation of Chloroform Vapour in Air by (*a*) Oil Absorption, (*b*) Densimetry: Dr. Waller.—The Temperature Limits of Nerve-Action in Cold-blooded and in Warm-blooded Animals: Dr. Alcock.—(1) On the Movement of Unionised Bodies in Solution in an Electric Field; (2) On the Passage of Nervous Impulses through the Central Nervous System: Dr. Hardy.

CONTENTS. PAGE

THURSDAY, JUNE 25, 1903.

SCIENCE AND THE NAVY.

II.

IN a former article[1] we referred at some length to the new Navy scheme, pointing out that in our opinion the scientific education of naval officers, and therefore the whole naval service of the country, must be vastly improved by its provisions. Since this article appeared there have been debates in both Houses of Parliament, including a most important one on May 9, in which Lord Selborne in an admirable speech gave some new information concerning the proposed scheme of education, and on the 15th inst. a circular letter was issued relating to the selection, training, and advancement of navigating officers. There has also been much discussion in the public Press; in this, as was to have been expected, scientific questions have been only lightly touched; and when the engineer question has been broached, its relation to the Admiralty practice regarding the other officers who must possess high technical knowledge has not, in our opinion, been pointed out.

But when we pass from the criticism of the new arrangements to the first steps actually taken to give effect to them, the opinion is quite general that the Admiralty is to be entirely congratulated. Prof. Ewing, who may be looked upon as the creator of the admirable engineering school at Cambridge, thereby showing that his powers of administration and organisation are on a par with his scientific acquirements, has been selected to fill the post of Director-General of Naval Instruction; his duty, we take it, will, to a large extent, be to do for the *personnel* what the Director of Naval Construction does for the *matériel* of the fleet.

We may be convinced not only that with such a strong man as this at the helm the complete scientific instruction of officers will be insisted upon, but that practical laboratory instruction of the juniors in mathematics and pure science will be secured.

Indeed, we may go further, and say that they have already been secured in most admirable fashion, for Lord Selborne, in the speech to which we have already referred, spoke as follows :—

"Without pledging myself to exact detail, I will give a general sketch of the kind of education that will be given. It includes not only that special education for which the school will exist, but that general education which every officer and gentleman ought to have. History, geography, physical geography, English and French will be taught. I do not say that other modern languages will not be taught. Mathematics, algebra, arithmetic, trigonometry, mechanics, physics, laboratory work, seamanship, drill and engineering will be taught. There will be laboratories and workshops in which the boys will be accustomed to the use of tools from the very commencement. There will be vessels of all sorts for use and demonstration, from a launch to a battleship, and generally an effort will be made, while not neglecting the general education of the boys, to start them from the moment of their entering the college on the education of a naval officer."

[1] Vol. lxvii. p. 289.

When we compare this programme with the one hour a fortnight in physics in the *Britannia*, and no laboratory within sight, students of science well recognise that naval education for the future will be conducted on business principles, and we may again express our regret that such a system, *mutatis mutandis*, is still a thing to hope for in some dim distant future in the case of the Army.

In our former article we pointed out how the subject of navigation suffered generally from the absence of a school afloat for practical work similar to those provided long ago for gunnery and torpedo work. Not only is this defect in the system to disappear in the case of the junior officers, but as stated in the circular letter to which we have referred, the regulations for the instruction of navigating officers have been revised so that a definite course of practical training may be given them in a navigation school ship which is about to be established at Portsmouth, with a suitable staff of instructors. The course of instruction while they are attached to the school ship will last for ninety working days, part of the time being spent at sea in the ship and the remainder on shore. While going through the course they will live on the school ship.

After the candidates have qualified in the school they will serve for a short period in the large ships of the Mediterranean, Home and Channel fleets, so as to obtain experience under the navigating officers in the work of a fleet in regard to navigating duties.

It would be difficult to overestimate the importance of these new departures, about which very little has been said in the various discussions of the new scheme, although, in our opinion, they are precisely those by which the greatest benefit to the service will be secured in the future.

Leaving on one side the objections to the new scheme which have been based on prejudice or a complete ignorance of the changes in any naval service which the progress of science has rendered inevitable, we may say that the question of the possible interchangeability of the officers at some distant date has attracted most attention in relation to the new training of the Engineers. On this point opinion has rapidly grown in favour of the new scheme, since inquiry has shown what a large common basis of pure science underlies the proper performance of any one of the specialised duties. The objections, in short, have been held by advocates of technical education in its worst sense, that is, the rule-of-thumb carrying out of practical processes without any inkling of the scientific principles involved.

We indicated in our last article that, although the new scheme provides for a system of interchangeability when once it is in full working order, the present practice is vastly different, and as we consider this interchangeability of paramount importance from the point of view of utilising to the utmost the results of the complete scientific instruction of our naval officers to be provided in future, it is important to return to this subject in somewhat fuller detail to show the important bearing of another part of the new circular.

We may begin by saying that our present naval officers, so far as their *scientific* training goes, may

be divided into two categories, well trained and less trained; these are the equivalents of the "specialised" and "not specialised" of the Admiralty memorandum setting forth the scheme.

The well trained or specialised officers have to deal with (1) navigation (but so far without a navigating school), (2) gunnery with a gunnery school, and (3) torpedoes with a torpedo school. We may say that the lieutenants performing these specialised duties comprise roughly about one-third of the total numbers. They get special allowances for their special duties.

But it must at once be stated that there are many duties on board ship for the proper performance of which special training, not of a scientific character in the ordinary acceptation of the word, is equally required, and, of course, these duties have to be provided for. They are carried on by the "unspecialised" lieutenants, who are roughly twice as numerous as those who have received a full scientific training. These are employed as watch keepers and in connection with general ship duties. They are "deck officers" as opposed to the scientific officers. The less scientifically trained or deck officer gets little or no allowance; on the other hand he is expected to spend money in painting ship. We see then that under the present system the officers performing each particular piece of work, whether scientific or merely professional, are for the most part in water-tight compartments; there are differences in the amount of special instruction they receive, the kind of work they do, and the allowances they get.

It was pointed out in the previous article that according to the present practice the less scientifically trained officers get the lion's share of promotions; that, in fact, the promotion has been in the inverse ratio of the scientific nature of the work done.

It has been urged in defence of this practice that scientific knowledge is of less value in the higher ranks than that which is derived from a complete mastery of all the details of a ship's general organisation, which can only be gained by the constant performance of the "deck duties" to which reference has been made. So that if we take the navigator, the most important scientific officer, on the one hand, and the first lieutenant, the most important deck officer, on the other, the thing works out in this way. The navigator, because his duties are so onerous and are never changed, knows nothing of deck duties. The first lieutenant, because his duties are never changed, is unlikely ever to become a competent navigator. The navigator, because he has not had an opportunity of learning deck duties, has his promotion retarded so that he can never get on the active list of admirals. The first lieutenant, because he is necessarily familiar with deck duties, is the first to be promoted, and is thus sure of employment on the active list of admirals.

The baneful effects of such a system as this, which are two-fold, were fully set out in our previous article. The Admiralty indicated its contempt for scientific as opposed to mere professional training, and the Admirals' list was swamped by men who knew little of navigation, although this, of course, finds one of its highest outcomes in handling ships in tactical exercises and in order of battle.

It was next shown that while, as determined by the scheme, the interchangeability of all officers, including the engineer officers, *must* be secured ten years hence, there were reasons why the interchangeability of at least some of the duties of the existing executive officers should be commenced at once. We rejoice to learn from the new circular that this also is to be done.

Lieutenants (N.) will in future be placed on exactly the same footing as regards executive command and ship's duty generally as gunnery and torpedo lieutenants, and are not to be excused from any ship's duties except those which interfere with the special duties pertaining to them. They will be appointed and succeed to the position of first lieutenant, if a vacancy occurs, in all ships where a commander is borne exactly in the same manner as any other specialist officer.

In rendering the special report on the qualifications of a navigating officer, a further clause is to be added, dealing with his capabilities as an executive officer.

Further, midshipmen who show special aptitude are, whenever possible when the ship is under way, to be taken off other duties, and to navigate the ship independently from the after bridge, fixing positions on the chart, and bringing the result of such work to the navigating officer.

Instead of one commissioned officer taking sights and working the reckoning daily, arrangements are to be made, when practicable, for one junior lieutenant or sub-lieutenant to be taken partially off watch-keeping so as to work with the navigating officer for ten working days under way.

The officer thus told off is to be on deck when coasting, making the land, going in and out of harbour, &c., and is to be in every way encouraged to get an insight into navigating duties. If at the end of the ten days the captain is satisfied with his work, he will be relieved and another officer is to be told off for this duty.

These important changes can be urged on two grounds. In the first place, there is the obvious benefit to the Service which will be secured when all captains and admirals are made equally acquainted with both their scientific and professional duties by interchanging them while they are lieutenants and commanders. In the second place, the preparation and simplification of the carrying out of the new scheme, by which another class of specialised officers, the engineers, will be introduced in the future, will be vastly facilitated by organising and testing the best way of interchanging duties on a small scale over a limited area.

We have referred chiefly to the navigator among the scientific officers, and no doubt the Admiralty has dealt with him first, because his duties are the most specialised; but if the interchange is advantageous in his case, the other specialists will follow, and, speaking only from the scientific side, knowing nothing of professional difficulties to be surmounted, it seems to us that such a preliminary experimental study of the

problem which awaits the Admiralty in the future, and which, if faced along the whole line, at the same time, may prove of Herculean proportions and be fraught with dangers of breakdowns, must commend itself as a scientific method. Our view of the wisdom of such an interchangeability among the present officers is strengthened by information which has been furnished us as to the procedure in the German Navy, which enables us to compare the two systems, and in our opinion fully justifies the policy of the new circular.

The distribution of duties amongst executive officers of the German Navy is as follows. As in the British Service every officer is educated in seamanship, navigation, gunnery and torpedo service. In the course of their service the various qualifications of the officers are carefully noted, and especially if they show superiority in any one of the above-mentioned branches. Ships in the German Navy are commissioned for two years. The list of officers for any given ship is made out by the Admiralty at Berlin. The next senior officer after the captain becomes the executive officer. After him the officer who is most proficient (according to the returns) in navigation and pilotage is appointed as navigating officer, without regard to seniority as lieutenant. He who is most proficient in gunnery is appointed "artillery officer," and so with the torpedo officer. Qualification regulates the selection of each officer for special duties, not his seniority as lieutenant. The specialisation of an officer for any particular duty only lasts for the two years' commission. In the next commission the navigating officer may be artillery or torpedo officer, or an ordinary watch keeper without special duty. It is *exceedingly rare* for an officer to be appointed for navigating duties *for more than two years*, as the Admiralty require every officer to go through a probation as navigator *in order to ensure that captains who are responsible for the navigation of the ship shall know their work in that respect.* An apparently weak point in this system is that for a time after the appointment of an officer to navigating duties ships are not so well navigated as they might be, since for the first few months of his time the navigator is really learning his work. Gunnery and torpedo work may be learnt in harbour, but navigating can *only* be learnt by actual practice and experience at sea. But, on the other hand, the strength of this system is that all officers have practical training at sea as navigators *with a captain who has gone completely through the navigating mill,* and knows how to detect any failure in the navigator which might endanger the ship. For squadrons an officer who has shown good ability as navigator in a single ship is selected as navigator.

On this system, whilst ability in any branch (N., G. or T.) is recognised, an officer is not unduly specialised to the detriment of his knowledge in other branches of his profession. In the British Navy the gunnery and torpedo officers are occupied with their special duties nearly the whole of their time as lieutenant, but they go to deck duties when promoted commander, although their knowledge of navigation and the handling of the larger ships is practically nil. But the navigator is occupied in special duties when promoted commander as well as during his service as lieutenant, *some fifteen years in all at least,* and is allowed no practice in other branches of a naval officer's profession, and because he has not been allowed to have any such practice, he is discharged to the coast guard, his naval career is broken, and the Service loses a man who has had the best possible training for leading ships into action.

Surely this comparison shows that the question of interchangeability has already been considered in the German Navy on the lines which we indicated as beneficial for our own; and in this we see an additional argument why the preliminary trial which we suggested on scientific grounds in our own Navy, and to which the Admiralty now stands committed, should at all events be welcomed as a first step to the wider interchangeability to which the Admiralty is certain to be forced in the future, for of the progress and need of science in the armed service of a nation there will be no end.

THE DISTRIBUTION OF DISEASES.

The Geography of Disease. (Cambridge Geographical Series.) By Frank G. Clemow, M.D. Edin., D.P.H. Camb. Pp. xiv + 624. (Cambridge: University Press, 1903.) Price 15*s.* 6*d.*

THE present writer had occasion recently to endeavour to ascertain, from the literature available in London, the distribution of a particular tropical disease. After spending several months on the work, the conclusion left on his mind was that the task was impossible in London alone, and that similar work in continental libraries would have to be undertaken before an accurate idea could be obtained. There is another method possible in the study of distribution, viz. personal investigation in various countries into the occurrence of a particular disease. The difficulties in the way of this method are perhaps not so great as one would think.

A notable instance of what we mean has lately been afforded by Hutchinson in his study of the "fish" ætiology of leprosy. Not content with accepting all evidence second-hand, he proceeded to South Africa and India and inquired critically into the statements which had been made against his view, with the result that many if not all of the "facts" (such as p. 229, "leprosy is found to be *common* in people whose religion and customs forbid them to touch fish") quoted as opposed to his views he was easily able to show were not facts at all, but mere hearsay evidence, which by constant repetition is at last generally believed. Many instances of this kind have come within the writer's own experience. Thus when first the mosquito malaria theory was definitely established on a basis of fact, it was asserted in print over and over again that no mosquitoes existed in such a place, but that malaria was rife there. As it was important to examine into these statements, the circumstances were carefully investigated in each particular instance, with the result that the "facts" vanished into thin air.

Another striking example is Manson's theory of

Filaria perstans as the causative agent of sleeping sickness (p. 408). This view had prevailed in the text-books for some time, but the Royal Society's commission has shown at once that the facts will not support this view. These then are instances where a personal acquaintance of even a few months' duration of the disease under consideration has considerably modified received opinions. But we cannot always hope to have critical inquiries of this kind by trained observers. We are, unfortunately, left with the second much inferior method, viz. the diligent searching out of all that has been written on the diseases in question, more especially in the latest periodical literature. Here we are immediately confronted with the difficulty of knowing what to believe amidst the mass of published articles, and when we see some of the sources from which the author has only too frequently quoted, we consider that he has not had a due appreciation of the extremely untrustworthy nature of much of his material.

With this qualification then, viz. a too ready willingness to admit the statements of uncritical writers, we can only find praise for the large mass of material condensed by the author. To hope to find any general explanation of the distribution of diseases is, we think, at present premature. We may point out finally some details of particular diseases where the information is inadequate or inaccurately set forth. On p. 237, the principal carrier of malaria is said to be *A. Claviger*. This is a curious statement, seeing that it does not occur in tropical Africa, India, Malaysia, &c. Possibly the author had Europe alone in his mind. Nor should we think that Grassi holds that any species of Culex can transmit malaria. The malaria of cattle is quite a different disease from that of man, and it is not accurate to use this term in reference to pyroplasma bovis (p. 243). Again, the malarial statistics of India have been, up to the present, so notoriously untrustworthy that we doubt much the value of quoting statements about "an increased production of the poison" in famine years (p. 248). Nor is it true that the Central Provinces are among the most malarious territorial divisions of India.

Turning now to that peculiar manifestation of malaria, blackwater fever (p. 44), we note the omission of Palestine as an important focus of this disease. So virulent is it there among the Jews that some villages have been deserted. On p. 51 the author writes, "whether hæmoglobinuric fever in man is due to the same organism as the red water fever of cattle is uncertain." In our opinion it is absolutely certain that it is not, for the simple reason that this organism (pyroplasma) of cattle has a characteristic and easily recognised appearance, and exists in abundance in the blood and organs, but has never been seen or described by anybody in the blood or organs of blackwater patients. The recent commission on malaria appointed by the Royal Society has likewise shown that in the Duars (India) it is as common as in tropical Africa. Nor do we consider that an abundance of observations has been published tending to disprove Koch's views of blackwater; on the contrary, the Royal Society's commission was of precisely the same view as Koch.

Sprue (p. 127) undoubtedly exists in India, as a typical case from there in a lady came recently within our knowledge. It is quite certain, however, that the ætiology and differentiation of hill-diarrhœas in India is completely obscure at present. We have already referred to the work of the sleeping sickness commission, but it seems probable that when its complete reports are published our knowledge of the distribution of Filaria will be considerably modified.

While we have pointed out in what respect we consider this book deficient, yet it must not be thought that we have not a full appreciation for the industry which it must have necessitated; and those students who wish to possess a well-arranged book of reference on the distribution of diseases ought to be exceedingly grateful to the author, but when consulting it they should remember that the subject is hardly yet capable of accurate treatment. J. W. W. S.

HYDRODYNAMICAL FIELDS OF FORCE.

Vorlesungen über hydrodynamische Fernkrafte nach C. A. Bjerknes' Theorie. Von V. Bjerknes. Band ii. Pp. xvi+316. (Leipzig: Johann Ambrosius Barth, 1902.) Price 10 marks, or 11.50 marks bound.

THE first volume of this book, which was reviewed in NATURE for November 3, 1900, is of a theoretical character, and deals with the stream lines in a perfect liquid considered especially with reference to the motions set up by moving solids and in particular pulsating, oscillating, or moving spheres. In it were obtained results now well known to students of hydrodynamics showing the existence of attractions and repulsions between the spheres, bearing a considerable analogy to the forces occurring in gravitation and other physical phenomena.

The interest of these results is greatly enhanced by the experiments described in the present volume. These experiments were commenced in the summer of 1875 by the late Prof. C. A. Bjerknes, who observed that if two spheres lighter than water (croquet-balls were used in the first instance) are allowed to fall into a tank of water from the same height, so as to set up vertical oscillations at the surface, they will approach each other if let fall simultaneously, and will recede from each other if let fall so that their oscillations are opposite in phase. From the fact that the volumes displaced by the spheres vary, the conditions are in many ways analogous to those produced in an infinite liquid by "pulsating" rather than oscillating spheres. From this beginning more elaborate experiments were devised. A sphere falling in liquid in the neighbourhood of a vertical wall in which its image could be seen by reflection was found to reproduce the attractions and repulsions indicated by theory for a pair of spheres moving symmetrically. The next experiments were conducted with spheres so fixed as to perform pendulum oscillations below the surface. The experiments were first performed at home, but from 1876 to 1880 Prof. Schiötz arranged for their continuation in

the Physical Laboratory of Christiania, and during the last two years Mr. S. Svendsen assisted in the work. About 1880, Prof. C. A. Bjerknes received from the Norwegian Government a private laboratory, where the experiments were arranged by the author with the assistance of Mr. J. L. Andersen. The result of these facilities was the construction of an elaborate instrument for measuring the attractions and repulsions of bodies pulsating in liquid. The generator consists of a system of pumps or drums operated on as bellows by cranks worked by a handle. These alternately force air in and out of the "pulsators," which may consist either of elastic balls, drums, or similar arrangements suspended in the water by a "pulsation balance," and the whole apparatus is now supplied by Ferdinand Ernecke, of Berlin. Another form of apparatus is described suitable for studying bodies oscillating in water without change of volume. Methods are also described of rendering the stream lines visible, and diagrams are shown illustrating the resemblance of these lines to magnetic lines of force.

The description of the experiments occupies the second part of the book. The first part consists of a summary of the main results, both quantitative and qualitative, which were established in vol. i., treated by elementary methods only, and it serves the purpose of enabling the physicist to read the present volume without studying its more mathematical predecessor. For such a reader the third part will have considerable interest, for it deals with the analogy of hydrodynamical phenomena with those of electrostatics and magnetism. Prof. C. A. Bjerknes's original discussions of these analogies having been given at a transition period in the development of electrical science, the writer of the present volume has largely remodelled the arguments in order that they may be studied in the light of modern electrical views. Between hydrodynamical and electric or magnetic fields of force, a close analogy exists *except in regard to the sign of the force*. The stream lines due to spheres executing pulsations of the same phase are identical with the lines of force due to like charges, but the pulsating spheres attract one another while the electrified spheres repel one another. If the pulsations are of opposite phases, the stream lines are the same as the lines of force of oppositely charged bodies, but the force is repulsive instead of attractive. Owing to this difference, the hydrodynamical field is to be regarded as affording a representation rather than an explanation of electric and magnetic fields, and as Prof. V. Bjerknes points out, a negative representation is still a representation, and it may admit of all the uses of a positive one.

Prof. V. Bjerknes has uniformly adopted the Heaviside system of "rational" electrical units, and he points out the great simplifications that arise from the use of this system, expressing his regret that the existing units were adopted before the advantages of the rational system had been fully appreciated.

The book will be read with much interest by physicists, and the reproduction of some of the experiments in the lecture room suggests a useful aid to the teaching of electricity. G. H. BRYAN.

FARM ACCOUNTS.

The Farmer's Business Handbook. By I. P. Roberts. Rural Science Series. Pp. xiii+300. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 4s. 6d. net.

THIS volume of the Rural Science Series consists firstly of an elementary account of book-keeping suitable to a small farm, and secondly a discussion of such legal questions as leases, tenant right, highways, fences, mortgages, taxes, &c., with which an ordinary farmer is likely to become conversant in the course of his business. This latter portion of the book is naturally only applicable to the United States, and though succinctly and clearly written, can be of little service to the English reader. In the earlier section of the book a system of book-keeping is set out by which the farmer can ascertain not only his profit or loss as a whole, but the result of his operations on each field or in each section of his business. The usual method of double entry is employed, though only day book (for which the American equivalent is apparently "blotter") and ledger are kept. The explanations are clear and simple, and may be read with profit by students who are beginning formal book-keeping, and are getting confused over the problem of Dr. and Cr. But we are by no means convinced that the ordinary system of double entry is the best method of handling farm accounts; naturally it can be made to deal with them, and for the cash account nothing different is wanted, but it is an extremely cumbrous means of ascertaining the profit or loss on individual crops or classes of live stock. Farmers are often reproached, and justly enough, with not keeping proper accounts, but it is not quite so easy a matter as in a business where all the items are in sight. So many of the figures must be estimates depending upon the judgment of the farmer; first of all the annual stock-taking has to be a valuation, in which market fluctuations have, or have not, to be considered, according to the purpose of the account. For example, a man has a breeding flock the number of which remains constant; in ascertaining his profits upon sheep-breeding it is best to take the value of the flock as constant, but in ascertaining his financial position at a given moment, he must re-value the flock at current rates. Again, many operations upon a farm are performed as much for their contingent advantages as for immediate return; the dung and cultivations given to the root crop have their value throughout the rest of the rotation; cattle are fattened for the sake of the manure they produce.

To one point the author of this book very properly gives special prominence, the item of household expenses; the house rent, the milk, potatoes, &c., consumed, the labour spent, are very often not taken into account at all, and the farmer sometimes comes to the conclusion that his farm is not paying when he is really living beyond his income. On the whole we believe that the ideal system is to open a ledger account for all cash transactions and for the house, and to keep separate running or progress accounts against the main branches of his business, such as the dairy

herd, sheep, crops, the latter account being occasionally specialised for a few years in order to ascertain whether a particular crop or field is paying its way. But we commend to the teachers of book-keeping in such of our agricultural colleges as possess a farm the problem of devising with an open mind an improved system of farm accounts, which shall be simple, actual, and helpful.

OUR BOOK SHELF.

The Rôle of Diffusion and Osmotic Pressure in Plants. By B. E. Livingston. Pp. xiii+149. (The University of Chicago Press, 1903.)

BIOLOGISTS who attach importance to the bearing of physics on their science must be gratified with the increasing number of books now appearing on such subjects as are treated in the book before us.

Mr. Livingston's short book is clear and readable, and contains a simple and concise sketch of much of the physics of diffusion and solution. The matter is well put, and difficulties are avoided. But concise treatment has its disadvantages, and, in one or two places, a false conception might be obtained from the author's descriptions. Thus there are notable exceptions to the rule that the particles of substances are brought closer together during the change from the liquid to the solid state. And it is scarcely fair to assume that the greater closeness of the particles is the cause of the greater rigidity of solids.

The limited space available in the book has apparently led to the exclusion of matter which it would be essential for the biologist to be acquainted with, and he should supplement it with the study of some text-book of physical chemistry. With regard to recent work, it must be regarded as unfortunate that the writer leaves out all mention of Brown and Escombe's work on diffusion through perforated septa from the physical part of the book, while in part ii., on physiological considerations, this investigation receives a bare mention by name in a small footnote. One would have thought that these authors' results would have been fully discussed as having a most intimate connection with the subject, and as bringing a completely new light to bear on our ideas of the diffusion of gases and of dissolved substances in plants.

The chapter on the terminology applied to solutions of different concentrations is very lucid, and should prove most useful to biologists.

In part ii. an account of turgidity and of absorption and transmission of dissolved substances in plants is given. Much information is imparted in a small space considering how nebulous are our ideas on the actual part played by the vital osmotic membranes of plants.

In the reviewer's opinion, far too much weight is accorded to Westermeier's and Godlewski's hypothesis explaining the ascent of water in trees. These writers assumed that the elevating force is to be found in the exudation pressure of the cells of the wood, cortex, and medullary rays. The physical relations of these cells to the water capillaries of the plant render the idea that the cells at different levels act as relay pumps impossible.

The theory of a tensile transpiration current is alluded to, but unfortunately it is criticised in the light of Copeland's undoubtedly misleading experiment.

The later chapters of the book are devoted to the osmotic effects of the medium on plants, and summarise most interestingly the recent results of osmotic and chemical fertilisation. H. H. D.

Mechanical Refrigeration. By Hal Williams, A.M.I.Mech.E., A.M.I.E.E. Pp. xiii+406. (London: Whittaker and Co., 1903.) Price 10s. 6d.

THIS book, which is devoted mainly to practical study of mechanical refrigeration and cold storage, should have a wide circulation, dealing as it does with a growing industry of which the literature, so far as text-books are concerned, is remarkably scanty. It opens with two chapters on the theory of heat engines and refrigerating machines. The first of these might well have been omitted, as it merely contains a series of definitions which can only be intended for a trader who is totally ignorant of the elementary theory of heat, and are somewhat apt to convey a wrong impression. The second chapter, on thermodynamics, is carefully worked out, the section dealing with the heat change consequent on the performance of internal work by the fluid being particularly interesting. A chapter devoted to the history of the subject leads to a short study of the methods of preparing the modern refrigerants, liquid carbonic acid and ammonia, and a description of the more important type of refrigerating machinery. In the latter section the author has confined himself to an account of ammonia and carbonic acid plant, and in this, considering the dimensions of the work, he is undoubtedly justified. Fifty pages of the book deal with the auxiliary plant necessary in a cold storage works. Finally, insulation, ice making, the construction and arrangement of cold storage works, and the application of methods of refrigeration to commercial processes are fully dealt with. The author wisely omits all mention of liquid air and its problematical applications. The book is well illustrated by means of photographs and diagrams, and the text is clear and concise. M. W. T.

Die stammgeschichtliche Entstehung des Bienenstaates sowie Beiträge zur Lebensweise der solitären u. sozialen Bienen (Hummeln, Meliponinen, &c.). Herausgegeben von Dr. H. von Buttel-Reepen. Pp. xii+138. (Leipzig, 1903.) Price 2.40 marks.

THIS is a book that should not be overlooked by those who are interested in the many important questions that are opened up by the habits of social insects. The author points out that the highly developed organisation of the life of the hive-bee does not stand alone, but may be traced up from the commencement of mere association of solitary species, through the less organised communities of humble-bees, &c., to its perfection in the hive-bee. A great number of outlying questions respecting parasitic bees, wax-secretion, &c., are also more or less fully discussed. The author is very anxious to eliminate, so far as possible, the natural tendency to anthropomorphise the actions of bees to too large an extent, and appears to take the view that inherited tendencies have to a large extent rendered their actions subjective and automatic. The index is very full, and is preceded by a list of nearly 200 books and papers dealing with the subject, which cannot fail to be of great value to any serious student of bee-life.

The Mind of Man. By Gustav Spiller. Pp. xiv+552. (London: Swan Sonnenschein and Co., Ltd., 1902.)

MR. SPILLER suffers apparently from the constitutional defects of extreme prolixity, and a marked contempt for the views of psychologists who have the misfortune to prove themselves "unscientific" by disagreeing with himself. The reader who is ready to overlook these deficiencies will find much interesting discussion of the principal problems of psychology in his book, though scarcely, I think, any considerable fresh contributions to the science. The author's fundamental point of view may be indicated by his definition of

psychology as the study of the functional needs of the central nervous system. His book exhibits great psychological learning, but is marred, I believe, by an ineradicable inconsistency of principle. He does not seem to have definitely made up his mind whether the processes of mental life are truly teleological (as he verbally asserts) or purely mechanical (as he frequently implies). Thus he exalts the significance of habit, or, as he calls it, "organised reaction," and minimises that of pleasure, pain and volition in determining action to a degree which leaves it a mystery how a new purposive reaction ever gets established.

A. E. T.

Heredity and Social Progress. By Simon N. Patten, University of Pennsylvania. Pp. i+214. (New York: the Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 5*s.* net.

Useful as analogy may be for purposes of illustration, it forms a precarious basis for scientific argument. Dr. Patten's book exemplifies the danger of attempting to formulate general laws on the strength of more or less superficial resemblances between phenomena belonging to diverse natural conditions. Such first-sight correspondences may legitimately be employed in the way of suggesting or indicating an underlying law, but in the absence of verification by comparison with all related facts, they are incapable of carrying an induction beyond its preliminary stages. These principles, which would seem to be sufficiently obvious, are practically ignored in the present work, which accordingly, in spite of some clever reasoning, is vitiated throughout by its faulty method. The author's premises being unsound from the outset, his arguments cease to be of interest except as exercises of logical ingenuity. A few examples will show the kind of biological doctrine to which Dr. Patten asks our assent. It is not such as to justify confidence in either his facts or his method. "The germ cell. . . has, therefore, the conditions of consciousness and more readily may be assumed to be the seat of consciousness than any other part of the body. In fact, by a process of exclusion it would seem to be the only possible seat of consciousness." "The nerve, in its effort to emit its sex products, presses against the skin and partially breaks through. The skin hardens over the injured part and the tooth results, which holds the nerve in." "The brain . . . is a sex organ that never attains its elementary functions." "The play of the emotions is sufficient to account for the reduction and disappearance of organs." It will be seen that the author is not to be taken seriously. His book is simply a monument of misapplied ingenuity.

The Educational Systems of Great Britain and Ireland. By Graham Balfour, M.A. Second edition. Pp. xxxi + 307. (Oxford: Clarendon Press, 1903.) Price 7*s.* 6*d.* net.

THE first edition of Mr. Balfour's book was published five years ago, and since that time events of the greatest importance have taken place in English and Irish education. The consequence is that the present issue differs in many respects from the previous one. To students of education the volume is already well known, at least by name, and in its enlarged form it should prove of great assistance to members of the new education authorities being formed in all parts of the country as a consequence of the passing of the Education Act, 1902.

The education of the British Isles is considered under the three headings—elementary, secondary, and higher, but, as Mr. Balfour says, this is likely to be increasingly difficult, as the three grades are becoming parts of that organic educational whole which it is essential to form in this country. There is one direction in which the value of the book might be much enhanced, and that is in showing what has been done in this country by private effort for higher education. No educationist has yet instituted an exhaustive comparison between the extent of private munificence in aid of higher education in this country and in the United States, though a beginning was made in NATURE (No. 1750). Such a comparison would do much to quicken public interest in higher education. The book may be recommended to all who wish to obtain an accurate and comprehensive idea of the present state of education in the British Isles.

A. T. S.

Alpine Flora. By D. J. Hoffman, translated by E. S. Barton. Pp. xii+112. (London: Longmans, Green and Co., 1903.) Price 7*s.* 6*d.* net.

IT is a notable fact that many travellers who have little or no knowledge of their native flowers often become keenly interested in the flora of the Alpine regions, and the reason is not far to seek, for the attraction lies in the richness of colour and lavish abundance which characterise the flowers growing on the mountains. There is therefore a demand for a book, with illustrations, preferably coloured, and written in fairly simple language, which will enable the amateur or novice to name his botanical specimens. Such is mainly the object of the present book, originally written in German and translated for the benefit of English travellers. It is naturally a difficult matter to decide which flowers to represent in a small book of moderate price, the limitations of which are imposed by the cost of production of coloured plates, and the selection is on the whole judicious. There are a few plants, such as *Hacquetia epipactis, Lilium carniolicum,* which are not found, or rarely so, in Switzerland and the Tyrol, which might have been excluded in favour of others of more common occurrence. The colour contrasts are good, excepting for a weakness in the tone of the pinks, and a similarity of blue in the gentians. Mrs. Gepp has introduced more precise terms in the English edition, which add to its scientific value, and yet should not offer any difficulty to the amateur, since a glossary is provided. The book may advantageously be used with Gremli's "Flora für die Schweiz," and will be a material help to those botanists who have not previously visited the European Alpine ranges.

Arnold's Country-Side Readers. Book i., pp. 144; price 10*d.* Book ii., pp. 176; price 1*s.* Book iii., pp. 214; price 1*s.* 2*d.* Book iv., pp. 236; price 1*s.* 4*d.* (London: Edward Arnold, n.d.)

Arnold's Seaside Reader. Pp. 264. (Same Publisher.) Price 1*s.* 6*d.*

THE title of the first four of these reading books for schools suggests that the reading lesson should be utilised to give the pupil some knowledge of the natural objects of the country at the same time that he is learning to read, and there is much to be said for such a plan. An examination of the contents of the volumes shows that much interesting information about common plants and animals is placed before the young learner; but there is so bewildering a medley of fairy tale with descriptive natural history that the boys and girls who are set to learn from the books will scarcely be able to decide where fancies end and facts begin. The same diversity of contents characterises the "Seaside Reader"; instructive lessons on fishes and other sea animals are interspersed with accounts of naval battles and biographical sketches of naval heroes. On the whole it would be wiser in such books to exclude the fairy tales and historical chapters; there is romance enough about natural science without other aid being necessary. The books are well printed and attractively illustrated.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Fœtal or New-born Giraffes Wanted.

WILL you give me the opportunity of making a request through your columns to museum curators and African sportsmen? I am especially anxious to obtain for study, preserved in spirit or dry, the head (*not* the prepared skull) of a new-born giraffe or of a late fœtal individual in which the boney ossicusps of the horns are already formed. I should be able to return the specimen after examination to the owner if desired. I should be glad to examine several such heads were it possible to procure them. All expenses of transport would be paid by me. I venture to ask those who can help me to communicate with me without delay.

E. RAY LANKESTER.

Natural History Museum, Cromwell Road, London, June 23.

Seismometry and Gëite.

BEFORE making a few comments on Prof. Milne's second letter under the above title (NATURE, June 12, p. 127), I should like to express my warm appreciation of his devotion to seismological research, and the great impetus it has given to observational work. In pure seismology—apart from applications of elastic solids to earth problems—Prof. Milne's reading is doubtless more extensive than mine, but if he is correct in regarding my first letter as containing nothing new to seismologists, they must, as a class, be singularly prone to a policy of *meliora scio deteriora sequor*. Novelty in results is, of course, much a matter of opinion. When Prof. Milne says, however, that there is no occasion for my warning as to Young's modulus, I must in reply give a quotation from his first letter, relating to the material of his hypothetical core, "it follows that the density . . . is 5·96, or approximately 6. *The* elastic modulus for a core of this density which conveys vibrations with a speed of at least 9·5km. per second is 451×10^{10} C.G.S., or roughly speaking, a little more than twice the Young's modulus for Bessemer steel." The italics are mine. If "the modulus" is not Young's modulus, E, a comparison between it and the E for steel is misleading, because a comparison of numerical results naturally implies that they refer to the same physical quantity. On this view the statement is doubly misleading, because there are *two* wave moduli, viz. $m+n$ and n. If, as one would infer from Prof. Milne's second letter, "the" modulus was intended for the wave modulus $m+n$, the futility of the comparison becomes obvious when we remember that on the ordinary theory $(m+n)/E$ may have any value between 1 and ∞, according to the value of Poisson's ratio. As a matter of fact, "the" modulus must, I think, have been intended at the time for Young's, though this must have escaped Prof. Milne's memory. If it were meant for $m+n$, we should have $(451 \div 5{\cdot}96)^{\frac{1}{2}}$ "at least" 9·5, whereas it is really only 8·7. If, however, we multiply 451×10^{10} by 6/5—which would be correct if 451×10^{10} were a Young's modulus in a material where Poisson's ratio had the uniconstant value 0·25—and substitute this, we deduce a wave velocity of 9·53km. per second.

Prof. Milne seems to have misunderstood my treatment of the two wave velocities in the *Phil. Mag.* (March, 1897, p. 199), and as it bears directly on the question at issue, I should like to make it clear. In previous papers I had advanced a variety of considerations pointing to the conclusion that, whilst all applications of elastic equations to the earth are more or less speculative, the mathematical and physical difficulties are enormously reduced when we suppose that the deep-seated material—about which we have no direct information—is nearly incompressible, *i.e.* has a Poisson's ratio approaching 0·5. Such a hypothesis, for one thing, rendered it unnecessary to assign to the rigidity and Young's modulus values largely in excess of anything yet encountered at the earth's surface. There remained, however, the fact of the high velocities observed in the more rapid earthquake waves, which had been generally supposed to imply enormously large Young's moduli, such, for instance, as the value 45×10^{11} given by Prof. Milne. The problem stood as follows:—

In an infinite isotropic elastic medium there are necessarily *two* wave velocities. If we know them both we can deduce all the elastic properties of the medium, provided we know the density; if we do not know the density, we can still deduce Poisson's ratio. If the medium is not infinite, but is bounded by a plane surface, then, as shown by Lord Rayleigh, there is a special type of surface wave the velocity of which, especially when the material is nearly incompressible, approaches closely to that of the slower or rigidity body wave natural to the material. If the bounding surface be not plane, but spherical or spheroidal, there is doubtless a wave answering to the Rayleigh wave, which within moderate distances of its origin may be expected very closely to resemble the Rayleigh wave in type, when the depth to which it penetrates and the wave-length are both very small compared to the central radius. If the medium have a Poisson's ratio of 0·25, the velocities of the two body waves must be in the ratio of $\sqrt{3}$(or 1·73) : 1.

In the earth there seems distinct evidence of only two types of waves. For the more rapid, supposing them to travel straight through, Prof. Milne himself would apparently take 10km. as the most probable value at depths below the immediate heterogeneous crust. It was important for my object not to understate this velocity, and I took the somewhat higher figure of 12·5km. The second type—which Prof. Milne terms the "large" waves—travel much slower. If they go straight through, their velocity is *less*, of course, than if they travel along the surface. On the former hypothesis, Prof. Milne might make them a trifle slower than the value I took, viz. 2·5km. per second. If, instead of 12·5 and 2·5, we took 10 and 2, we should obtain, of course, the same value of Poisson's ratio as before, 0·48 approximately, with a value for E somewhat *less* even than the very moderate value (about 10×10^{11} C.G.S.) obtained in my paper. If we took 10 and 2·5, or even 10 and 3, for the two velocities, we should get 0·47 and 0·45 for the values of Poisson's ratio.

The uncertainty as to whether the "large" waves were body waves or surface waves—or, as I thought more likely, a combination of the two—was not overlooked, as Prof. Milne's letter might suggest, but was dwelt on at some length in the paper. If they are *entirely* surface waves, the heterogeneous nature of the earth's crust, and the irregularities of mountain and ocean, are such as to introduce extreme uncertainty into any mathematical calculations. In this event it is doubtful whether any conclusion can be drawn either for or against the hypothesis of great incompressibility in the core; its explanation of the high velocity in the faster waves would, however, be unaffected.

The discussion of magnetograph results by Prof. Milne in the B.A. Reports for 1898 and 1899 (1888 is surely a misprint) was familiar to me as a contributor of data, but it did not seem to render my letter unnecessary. I suspect, however, that I partly misunderstood Prof. Milne's letter on this part of the subject, as I did not fully realise that he did not recognise the distinction between anomalous and merely high values of the horizontal force H. The fact that H is nearly twice as large at Batavia or Bombay as at Kew is natural, owing to their proximity to the magnetic equator. Whether the values at these stations are higher or lower than one would expect from their geographical position cannot be said with certainty until the completion of magnetic surveys. What my letter suggested was the advantage for critical purposes of records at a station where there is known to be a true *large* magnetic anomaly—*e.g.* in N.E. Ireland or the Scottish Highlands. Variations in the value of g are, relatively considered, trifling compared to those in H, and the larger gravitational anomalies present systematic features to which there seems no parallel in magnetics (*c.f.* Bourgeois' discussion of g in the "Rapports présentés au Congrès International de Physique," Tome iii., Paris, 1900). Apart from the question of the unit, I am a little puzzled by Prof. Milne's gravitational data for Kew, and I should warn him that there, as at some other stations, the agreement between different observers at different times has not been such as to warrant much reliance in any one observer's value for $g - \gamma$ (*i.e.* gravity observed less calculated).

C. CHREE.

Phenomena of Vision.

YOUR correspondent, Mr. W. Betz, refers in his letter of May 7 to the fact that an object just screened from direct vision by the nose (or by any other obstruction) becomes visible if we rotate the eye in a direction away from the object. This is a well-known phenomenon, and a very interesting one on account of the curious facts with regard to vision that can be deduced from it; but it is not in any way due to spherical aberration. It is rather a perspective effect, being caused simply by the shifting of the point of sight, which, being situated near the crystalline lens, moves laterally as the eye is rotated about its centre. There are several ways of demonstrating the movement of the point of sight, but the experiment described by Mr. Betz is perhaps the most convincing.

An interesting corollary of this experiment is the generally unfamiliar fact that we employ two points of sight simultaneously in the act of vision, though we may use one eye alone. Speaking generally, the eye wanders over any object we may be examining with slight pauses at each point of interest. Only at each pause do we really see, and our final mental impression of the whole object may be described as a mentally combined image of a series of "snap-shots." The retinal image produced at each "snapshot" is a perspective view with the node of the crystalline lens as the station point. The final mental picture is, however, a view with the centre of the eyeball (or its centre of rotation) as a station point. This latter view is smaller than the other, by reason of the fact that the centre of rotation is some little way behind the crystalline lens, hence the apparent size of an object varies as we study it. The general effect is further complicated by the lateral movement of the crystalline lens, which causes each momentary snapshot to be taken from a different station point; also the final impression is more or less influenced by the impression gained during the last fixed glance. Therefore we may conclude, with a considerable amount of reason, that we do not see objects exactly as they are. Really we only see a combination of a number of views taken from different points, and to arrive at a true understanding of what we see we must employ our capacity of reasoning. The extraordinary complexity of our mental visual conception is often deceptive, though unconsciously so to many people who have no idea of the peculiarities of vision.

The various effects of the employment of the two station points are not likely to be appreciated unless looked for, but once you realise the fact, evidence is easily collected. One of the most striking effects is the apparent movement of fixed points. In the experiment described by Mr. Betz the object point seems to play hide and seek with you, popping out from behind the screen when you look in another direction, and dodging back again when you try to look straight at it. It seems to move with the eye, but this effect is due mainly to the presence of the screen, for under other conditions it will generally be found that the apparent movement is opposite to that of the eye. The following experiment illustrates both the illusion of movement and also the dependence of apparent size upon the direction of vision.

Place two objects at different distances from the eye and subtending a moderate angle at the eye so that both can be seen when one is directly looked at. Look fixedly at one object and estimate the distance between the two. Then traverse the eye slowly on to the other object, and the distance between them most distinctly alters, the effect being apparently due to a shifting of one or both of the objects. You will find it somewhat puzzling to account for all the various effects of movement that can be detected under different conditions, but if you take all factors into consideration, you will, I think, eventually find that the shifting of the station point is primarily responsible for all the effects produced, other than those due to spherical aberration.

C. WELBORNE PIPER.

May 15.

MR. PIPER'S explanation of the curious phenomenon pointed out by Mr. Betz is presumably correct; that there are two station points used in vision can, however, scarcely be demonstrated. The positions of the nodal points of the eye are shifted during accommodation for near vision, and perhaps this displacement is what Mr. Piper refers to. In general it is difficult to observe the apparent motions of objects which Mr. Piper mentions, and it is still more difficult to trace such motions to the optical properties of the eye, since we are here dealing, not with optical images which can be directly examined, but with mental impressions. Thus König pointed out (*Wied. Ann.*, xxviii. pp. 367–368, 1886; "Gesammelte Abhandlungen zur physiologischen Optik," xiii. p. 58, Leipzig) that patients, on first being provided with strong divergent spectacles, complain that, on moving their eyes without turning their heads, stationary objects appear to move. After a time this apparent motion ceases to be observed, or, indeed, to be observable, but on removing the spectacles stationary objects appear to move in a sense opposite to that previously observed with the spectacles. In this case a readjustment of judgment respecting visual impressions has been effected; the result shows to what a great extent judgment enters into the act of vision.

EDWIN EDSER.

June 13.

School Geometry Reform.

IN the unsigned review of Prof. Barrell's "Elementary Geometry" appearing in the issue of June 18, the following sentence occurs:—"A feature to be noticed is that the author gives three meanings of a plane angle, in the last of which the angle is regarded as the plane space swept out by a line of indefinite length (one way) turning about one end." It is unsafe to say that such a definition is wrong, but it is certainly most undesirable in a school book. The apprehension of the true nature of an angle is one of the greatest difficulties that the beginner has to encounter, and the way is not smoothed by the introduction of the idea of an infinitely extended space. It is true, as Mr. Russell points out ("Principles of Mathematics," p. 416), that the definition can be made logically satisfactory if the axiom of the whole, being greater than its part, be rejected; but this is an intolerable objection. The best course for an educational book is that adopted by Ronché and De Comberousse ("Traité de Geometrie," 1891, p. 5), who say:—"La considération de deux droites qui se rencontrent conduit à une idée nouvelle, qui est celle d'*inclinaison* mutuelle ou d'*angle*, et qui, comme l'idée de longueur, ne saurait être définie, c'est-à-dire ramenée à une idée plus simple."

R. W. H. T. HUDSON.

June 22.

RECENT EXCAVATIONS AT NIPPUR.

IT was in 1884, at a meeting of the American Oriental Society, that the first plans of an expedition to Southern Babylonia were projected, and from that year dates the beginning of the systematic scientific work which is being carried on by the Americans at the mounds of Nuffar, the ancient Nippur, with all possible thoroughness. Since the year 1888, there have been four expeditions sent out to excavate this ancient site, and there is still much to be done there. The first resulted in the discovery of a Parthian palace, and many "finds" from systematic diggings in the Temple of Bel, the cuneiform tablets alone numbering two thousand; but ill-luck overtook the members of the party, and, owing to trouble with the Arabs, the camp was burnt and they themselves were robbed. However, the next year, on reopening the works, there was no opposition, and the labours of the expedition were rewarded with eight thousand tablets of the second and third millennium B.C., and in the third campaign many pre-Sargonic ruins were discovered, besides more than twenty thousand tablets. The last expedition, which came to an end in 1900, was the most successful of all; the Parthian palace was completely explored, and, what was more important, the great library of the Temple of Bel was located, and twenty-three thousand clay tablets were excavated therefrom, thus bringing the total number found up to more than fifty thousand.

Looking at the results of the four expeditions, we are struck with the careful way in which all operations have been conducted, especially towards the end of the period. The mounds were carefully surveyed, and even a relief map of them was made in plaster, the buildings which were discovered were accurately mapped, numerous photographs were taken of the various phases of the diggings, and as time went on those in command became even more methodical in their diggings. The manner in which the excavations were carried on merits the highest praise.

The "section" of the shafts dug through the mounds, as figured by Prof. Hilprecht in his latest work, "Explorations in Bible Lands" (p. 549), shows, as is common in ancient mounds, that the city was occupied from a very early period, and that from time to time new builders superimposed their pavements and dwellings upon those of an earlier period, so that the mounds are made up of successive layers, each marking an earlier building as the shafts sink lower. The diggers first cut through soil containing Sassanian and early Arabic remains. Then came the great Parthian fortress of the second or third century B.C. Next were found in six successive strata the pavements of buildings of (*a*) Ashurbanipal, who restored the great *ziggurat*, or temple-tower (*c.* 668-626 B.C.); (*b*) Kadashman-turgu (*c.* 1350 B.C.); (*c*) Ur-ninib (*c.* 2500 B.C.); (*d*) Ur-gur (*c.* 2700 B.C.); (*e*) Lugal-surzu (*c.* 3500 B.C.); (*f*) Sargon and Naram-Sin (*c.* 3750 B.C.). Below these, and beneath the level of the surrounding plain, a vaulted drain came to light, of a period distinctly before Sargon, and in the heart of the mound, on a slightly higher level, was a pre-Sargonic *ziggurat*. Straight down through these layers, from almost the top to the very water-level, a Parthian well had been sunk, a total distance of about seventy feet in depth. The mound of Nippur is therefore similar to Hissarlik and Tel-el-Hesy in the superimposition of cities.

The larger of the two Parthian buildings was a palace and fortress occupying what had been the centre part of the old Babylonian temple, and was an almost rectangular building surrounded by an enormous double wall, five hundred and sixty feet long on its south-eastern front. From the discovery of great masses of water-jars piled together in the southern part, as well as various fire-places and other kitchen arrangements close to them, it is clear that these were the servants' quarters, storehouses and bakeries. In the centre of the whole building rose the citadel, built over the ancient *ziggurat*, and it was through this that the only well of the whole building had been dug, evidently with the idea of the garrison holding out against a long protracted siege.

The smaller Parthian palace, west of the Chebar, which has been completely excavated, was a square building, measuring each side about 170 feet. It apparently had but one entrance, which was situated in the centre of the north-west façade. The walls varied in thickness from three to eight and a half feet, and the material used in the construction was brick, baked and unbaked. The roof, as the pieces of charred wood discovered in the ruins plainly show, was of palm logs, matting and earth. Prof. Hilprecht divides the building into two almost equal parts, the one for public functions and the other for the family life.

But important as these two buildings were, their interest cannot compare with the discoveries of earlier Babylonian ruins. Of these the huge *ziggurat*, or tower of the Temple of Bel, stands out pre-eminent, a huge brick building, the origin of which dates back to pre-Sargonic times, and shows in its various strata traces of the handiwork of the many kings who restored and added to it. According to Prof. Hilprecht, the Temple of Bel (called Ekur in the cuneiform inscriptions) was divided into two principal buildings, the *ziggurat* or great tower, and the "House of Bel." The whole was surrounded by the great wall called *Imgur-Marduk*. It is to this temple that the energies of the excavators have been principally directed, and from it have come the majority of the tablets found. The temple in Babylonia was not only a place wherein the gods might be worshipped, but was also a college at which priests were trained, and for this a reference library was essential. Consequently, it is not going too far to say that probably every important temple in Assyria and Babylonia had its own library of clay tablets. An excellent idea of what the temple rooms looked like may be gained from the photograph in Prof. Hilprecht's book, "Explorations in Bible Lands," p. 509.

In the remains of this Babylonian city many discoveries were made which add considerably to our knowledge of the daily life of the inhabitants. One of the most remarkable things found was a baking furnace made of brick, dating back to the third millennium B.C., composed of a series of seven (originally nine) parallel arches over a fire-box, which ran lengthwise through the whole kiln. It was, in fact, very similar to the military field-ovens in use at the present day. Still earlier is the specimen of the elliptical arch which Haynes discovered, which Prof. Hilprecht assigns to the fifth millennium B.C. This is undoubtedly the first Babylonian arch known, and will go far to prove the much-disputed question of the origin of the arch.

Up to the present comparatively few of the tablets discovered in the ruins have been published, so that it is impossible to speak of the possibilities of the great temple library. We may notice, however, an important clay map of Nippur, photographed in Prof. Hilprecht's book (p. 518), which gives the environments of that ancient city as they were about two thousand five hundred years ago. Interesting, also, are the "practice" tablets, written by the pupils in the schools during their study of the Babylonian language. Indeed, it is to this class of tablet that we owe much of our knowledge of the classical works in cuneiform, for many similar are preserved in the British Museum which are inscribed with excerpts from the Creation legends, syllabaries, and incantations.

Much remains to be done at Nippur, and it is to be hoped that the Americans will continue and complete the great work they have begun. There is little doubt that when the mounds of Assyria and Babylonia have yielded up their hoards of cuneiform tablets stored up in the palace and temple libraries, our knowledge of those countries will equal, if not surpass, what we know of the archæology of Greece and Rome.

MATHEMATICAL REFORM AT CAMBRIDGE.

THE syndicate appointed in December, 1902, to consider what changes, if any, should be made in the regulations affecting the mathematical portions of the pass examinations of the University of Cambridge has recently presented a report which has just been adopted by the Senate, and will profoundly and beneficially affect the teaching of the subject in our public schools and throughout the country.

Recognising the widespread desire for reform, noting the changes that have already been made in the schedules of important examining bodies, and having examined the recommendations of various committees, the syndicate is convinced that changes are desirable, and that a "modification of the requirements of

examinations is a necessary preliminary to any substantial improvement in teaching."

The syndicate has, therefore, made recommendations affecting the subject-matter of the Previous Examination. The alterations will begin to operate in the Lent term of 1904, and will finally supersede the present regulations after October, 1905. The principal changes may be summarised as follows:—

(1) In demonstrative geometry, Euclid's Elements shall be optional as a text-book, and the sequence of Euclid shall not be enforced. The examiners will accept any proof of a proposition which they are satisfied forms part of a systematic treatment of the subject.

(2) Practical geometry is to be introduced, along with deductive geometry, and questions will be set requiring careful draughtsmanship and the use of efficient drawing instruments.

(3) In arithmetic, the use of algebraical symbols and processes will be permitted.

(4) In algebra, graphs and squared paper work will be introduced; and a knowledge will be required of fractional indices and the use of four figure tables of logarithms.

The scope of the subject-matter in geometry is set out in two schedules. The first gives a list of constructions in practical geometry. We venture to take exception to one detail in this list, that of requiring a construction for drawing a common tangent to two circles. Why insist on first finding the points of contact? This may have been necessary under Euclid's postulates, but it should now be discarded; it is not practical geometry.

The second schedule indicates the amount of book work necessary in preparing for the Previous Examination. The propositions enumerated are nearly all contained in the Elements, but a judicious amount of pruning has been effected in the latter. Hypothetical constructions are permitted. The theory of incommensurables is not required.

The increase of freedom now being given to teachers should lead to further developments in the reform as experience is gained. It will be one great advantage to have the several branches of the subject brought into closer association and reacting on one another.

Geometry will be made generally interesting and will at last have a chance of being taught in a manner suited to boys. In looking out for suitable numerical examples in geometry, we predict that a good teacher will not fail to make use of functions of angles. Probably three figure tables of chords, sines, cosines and tangents will be sufficient, reading to tenths of a degree, and occupying a very modest space. A boy's interest will be stimulated when he discovers the latent power residing in these innocent looking tables. And in checking his graphical results, he may be led on to the numerical solution of right-angled triangles before he has heard of trigonometry, and will never afterwards be repelled by the symbols sin., cos., tan.

The employment of logarithms is most important. Their use illustrates the significance of fractional indices. And here again the interest of a boy must surely be aroused when he finds himself in possession of a new, unforeseen, and most valuable means of calculation.

The introduction of graphs is of great value. The fundamental idea of the representation of position and change of position by means of rectangular coordinates is thus acquired early and in an agreeable manner. Some teachers find that it is quite possible to go on without much delay to easy illustrations of the calculus.

Looking ahead to possible developments, the graphical use of polar coordinates to mark position and change of position, by the plotting of lengths and angles, might serve as an introduction to the study of vectors, a subject of first importance, and at present so woefully neglected.

We regard this reform at Cambridge as an important step in the movement now in progress throughout the country, and we hope to see it carried much farther before crystallisation takes place.

THE UNIVERSITY OF LONDON.

THE presentation for degrees of the University of London, which is to take place in the Albert Hall as we go to press, under the presidency of the Chancellor, Lord Rosebery, is noteworthy in several respects. For the first time in the history of the university, honorary degrees are to be conferred, the recipients being their Royal Highnesses the Prince and Princess of Wales, Lord Kelvin, and Lord Lister. The Prince is to receive the honorary degree of Doctor of Laws, the Princess that of Doctor of Music, and Lord Kelvin and Lord Lister that of Doctor of Science. Ordinary degrees are also to be conferred on 414 persons who have obtained them during the past year. Moreover, the occasion is remarkable as being the first gathering of representatives of all the different institutions and groups of persons connected with the university.

The reconstituted university has opened up new avenues of work in connection with schools, with university extension, with the colleges, medical schools, and polytechnics; students are entering both for the ordinary matriculation examination and for post-graduate study and research in unexpected numbers. The educational forces of London have, in fact, been organised by the university, and public interest is being shown in the work. But, as Sir Arthur Rücker, the principal, has pointed out, while there are many grounds for hope, and while the university is doing its best to make itself worthy of public support, it can never fulfil its duties without the supply of funds from public or private sources on a very large scale. We trust that one result of the brilliant ceremony on Wednesday evening will be an increase of the endowment of the university sufficient to secure the full development of the scheme which has already produced such satisfactory results.

NOTES.

FOR the first time for about forty years the Royal Society of Edinburgh, on the evening of June 6, held a conversazione. Lord and Lady Kelvin and Sir William Turner received the guests. There were many interesting exhibits from several departments of the Universities of Edinburgh, Glasgow, and St. Andrews, from the Geological Survey of Scotland, the Scottish Antarctic Expedition, &c. Prof. McIntosh, of St. Andrews, sent over a large collection of pearl shells and animals, living and dead, and great interest was taken in Prof. Ewart's exhibition of hybrid ponies. Some of the lantern exhibits were particularly attractive, notably the projection on the screen of tanks of living worms, crustacea, &c., and a fine selection of slides made from Piazzi Smyth's "cloud" negatives. Among the inventions and novelties exhibited, Dr. Halm's instruments for mechanically correcting stellar observations and for solving Kepler's problem in any given case, and Dr. Hugh Marshall's petrol incandescence lamp are worthy of mention.

CAPTAIN AMMUNDSEN'S Magnetic North Pole Expedition left Christiania on June 16 on board the ship *Gjoa*.

WE regret to announce the death, on June 10, of Prof. Luigi Cremona, director of the engineering school of the University of Rome.

THE summer meeting of the Institution of Naval Architects was opened at Belfast on Tuesday, and Lord Glasgow delivered his presidential address.

THE retirement of Sir James Hector, K.C.M.G., from the directorship of the Geological Survey of New Zealand and of the Colonial Observatory is announced by the *Victorian Naturalist*.

MR. MARCONI'S manager at Glace Bay, Nova Scotia, states that the company is transmitting daily wireless messages from Table Head to Poldhu, but the replies are being cabled pending the installation of machinery at Cornwall.

THE *Times* announces that Commander Don Julian Irizar, Naval Attaché to the Argentine Legation in London, has been appointed to command the vessel *Uruguay*, which will be sent by the Argentine Government in October to the Antarctic regions in search of Dr. Otto Nordenskjöld's South Polar expedition, which was joined at Buenos Ayres in 1901 by an officer of the Argentine Navy.

A GRANT of 5000 dollars, and travelling expenses to the amount of 1500 dollars, has been made to Prof. Arthur Gamgee by the Carnegie Institution for the preparation of a report on the physiology of nutrition, the object being to enable him to secure information which may lead to the organisation in the laboratories of various countries of cooperative research in the important problem of human nutrition, &c.

PROF. STEINMANN, of Freiburg, and two of his fellow-geologists of the same University, have arranged an expedition to the Central Andes of Bolivia. The party will start in August for Buenos Ayres, whence the route to be taken is *viâ* Jujuy, Tarija, Sucre, to Cochabamba. After a prolonged stay in the mountains the explorers will probably work their way to Antofagasta *viâ* La Paz. The outfit is of the most modern description, and Dr. Hoek, who is a member of the expedition, is one of the most capable German mountaineers.

THE International Fire Prevention Congress convened by the British Fire Prevention Committee will be opened at Earl's Court on Monday, July 6, by the Lord Mayor of London, who will be accompanied by the Burgomaster of Brussels. The general and sectional discussions will be held on the forenoons of July 7, 8, and 9. The testing operations and inspections are fixed for the afternoons of these days.

THE Royal Statistical Society announces the next competition for the Howard medal (1903–1904). The essays must be sent in on or before June 30, 1904. In addition to the medal, a grant of 20*l.* will be awarded to the writer who may be the successful competitor. The subject is "The Effect, as Shown by Statistics, of British Statutory Regulations, Directed to the Improvement of the Hygienic Conditions of Industrial Occupations." Full particulars may be obtained at the office of the Society, 9 Adelphi Terrace, Strand.

THE concluding meeting of the thirty-eighth session of the Aëronautical Society of Great Britain will be held on the Sussex Downs this afternoon. On this occasion will take place the international kite competition (wind and weather permitting) for the silver medal of the Society, in accordance with the rules and regulations drawn up by the council of the Society and the jury of the competition. Amongst those who have consented to act on the jury are Dr. W. N. Shaw, F.R.S., Prof. C. V. Boys, F.R.S., Mr. E. P. Frost, Sir Hiram Maxim, Dr. H. R. Mill, Mr. E. A. Reeves, and Mr. Eric Stuart Bruce.

WE learn from the *Lancet* that Dr. Loudon, of St. Petersburg, has published some interesting observations relative to the action of the Becquerel rays on the nervous system and on the eye. He found that when a box containing bromide of radium was placed in a cage in which mice were kept the animals became paralysed and comatose, and died in five days. He also found that persons who are either totally blind, or have only the feeblest possible perception of light, are peculiarly sensitive to the Becquerel rays, and are able to form visual conceptions of the contour of objects the shadows of which are shown on a screen by means of the rays.

THE following note referring to observations of sunrise at Stonehenge on Sunday appeared in Monday's *Times*:—For the first time for nearly ten years visitors to Stonehenge yesterday morning saw the sun rise over the altar-stone. There was an almost cloudless sky, and at forty-three minutes past three the sun appeared above the horizon and rose in a direct line over the altar-stone. It was a magnificent sight, and after a moment's silence the crowd gave a mighty cheer. There were some hundreds of people present, many of them having travelled in previous years many miles during the night preceding the longest day in the hope of seeing the sight which was seen under such favourable conditions yesterday morning.

SLIGHT earthquake shocks were felt in North Wales and Anglesey on the morning of June 19. Mr. Fred. C. Carey, of the County School, Bethesda, writes to us that the first shock was felt by him in the county school at 10.8 a.m. precisely, when a distant rumbling noise, lasting about a minute, was heard, and the whole building shook. Slighter tremors followed at 10.12·5, 10.16, 10.19·5, 10.27, and 11.11·5. At Carnarvon the buildings trembled violently. At Bangor the shocks were felt at about the same time. The bells rang at the railway station. The post office at Llanrug was much shaken. The shocks were general throughout Carnarvonshire, and were felt as far as the southern part of the Isle of Man. The vibration appeared to travel in a north-westerly direction. In Anglesey the shock was comparatively slight.

IN connection with the meeting of the International Meteorological Committee at Southport during the British Association week in September next, it is proposed to make arrangements for an exhibition of meteorological appliances and other objects of meteorological interest. Upon the initiative of the Meteorological Council, with the co-operation of the Royal Meteorological Society and the Scottish Meteorological Society, a committee has been formed to carry out this proposal. It is proposed to group the exhibits into four classes:—(*A*) meteorological statistics; (*B*) weather telegraphy; (*C*) atmospheric physics, including (*a*) meteorological photography; (*b*) instruments and instrumental records; (*c*) high level stations, balloons and kites, observations and records; (*d*) experimental illustrations; (*D*) the relation of meteorology to other branches of physics.

THE weekly weather report issued by the Meteorological Office for the week ended June 20 shows that over the southern part of England the rainfall was three times as much as the mean, while in the east of England it was more than seven times as great. Further, that the rain-

fall since the beginning of the year is in excess of the average in all districts, varying from more than 10 inches in the north of Scotland to 0·9 inch in the north-east of England. During the first three weeks of this month the amount measured near London was upwards of 6 inches; the Greenwich records for the last 60 years show that the heaviest previous fall in June was 5·80 inches, in the year 1860. At Malin Head the fall in the same three weeks was only 0·05 inch, and at Holyhead only 0·4 inch. But on June 22 an area of low barometric pressure reached our western coasts and occasioned heavy rain, amounting to an inch and three quarters at Valencia in the forty-eight hours ending 8h. a.m. on June 24.

The cleanliness of electric lighting has always been urged as one of the great claims in its favour, and it has been justly pointed out that the saving effected in redecoration partly balances its extra cost. Although this is true, electric light cannot be regarded as perfectly clean; it has long been noticed that there is a marked tendency for dust to accumulate on electric light fittings and wires, and on the walls and ceilings in their immediate neighbourhood. This is partly, no doubt, due to the air currents produced by the local heating, but it is also partly an electrical phenomenon. The dust particles floating in the air are presumably at air potential, and are consequently attracted to the conductors on the non-earthed side of an earthed system; they either stick to these permanently, or remain on them until charged, when they are projected on to and stick to the walls. The defect has naturally become more marked with the increased use of 200-volt systems. If switches are always put, as they should be, in the non-earthed wire, the deposition of dust will only occur during the time the lamps are alight, and will be minimised. Mr. D. S. Munro, writing in the *Electrical Review*, points out that a still further improvement can be effected by using concentric flexible conductors instead of the ordinary twisted cord, the outer conductor being connected to the earthed side of the system.

Dr. Edington read a paper at the recent meeting of the South African Science Association upon the occurrence of an epidemic among domesticated animals in Mauritius, in which trypanosomata were found in the blood. It attacked cattle, mules, horses, and donkeys, among which it caused an alarming mortality, and seemed to be allied either to nagana or to surra.

The commemoration day proceedings of the Livingstone College were held at Leyton on June 10. The College trains missionaries in the elements of medicine and surgery. The Bishop of St. Albans, who presided, stated that there could be little doubt that the average life of a man abroad was considerably extended when due care was taken to observe the rules of health. He referred to the importance of training women as medical missionaries for work in India, and to the moral effect exerted upon native races by curing their bodily ailments.

The annual return showing the number of experiments performed on living animals in the United Kingdom during 1902 has been issued as a Parliamentary paper (186). In England and Scotland the number of licensees was 319, of whom 112 performed no experiments. The total number of experiments performed by these was 14,906, of which 2130 were carried out under anæsthetics, and the remainder, 12,776, were of the nature of hypodermic inoculations. The inspector, in his report, directs attention to the large number of experiments performed for the preparation of remedies and on behalf of various public authorities. Five licensees alone performed 3857 inoculation experiments for testing anti-toxins, and fifteen licensees 3997 inoculations for public bodies for the purpose of testing milk for tuberculosis, for the examination of sewage and of air, and the like. As regards Ireland, 13 licences were in existence during the year, and 65 experiments were performed under them.

We have received from the director of the Survey Department, Cairo, a report on the meteorological observations made at the Abbassia Observatory during the year 1900, together with mean values for Alexandria for the previous ten years: also monthly results for Port Said, Assiut and Omdurman for part of the year 1900. The report is a very valuable contribution to Egyptian climatology, and bears evidence of every care having been taken in the selection of trustworthy instruments and in the reduction of the observations. The observatory is now well supplied with automatically registering instruments of the best patterns, including Dines's anemometer, Callendar's electric recorders for dry- and wet-bulb platinum wire thermometers, Campbell-Stokes's sunshine recorder, and Milne's seismometer. For Abbassia hourly observations are given, and the results, with daily and annual variations and other data, are shown in clearly drawn diagrams, both for this station and for Alexandria. From the latter ten-year series we note that the mean of the highest temperatures recorded in each month was 36°·6 C. in May, and of the lowest maxima 21°·6 in January; the mean of the highest minima was 22°·7 in August, and of the lowest 7°·0 in January. The extreme values were 40° and 5°·4. The mean annual rainfall is only 9·53 inches; most of this falls between November and January. No measurable quantity falls in June, July and August, and only three-tenths of an inch, on the average, in September.

In our recent notice of Messrs. Burroughs Wellcome and Co.'s "tabloid" preparations for photographers, we remarked that, among a very large assortment of reagents and mixtures, mercuric chloride and ferrous oxalate appeared to have been overlooked. The firm informs us that the mercuric iodide and sodium sulphite intensifier is so efficient that it does not consider the issue of mercuric chloride tabloids as desirable. We would point out that intensification is the only process subjected to such a limitation, and that, although the iodide of mercury method is easily applied and the tabloids are excellent for the purpose, there is no method of intensification that is so simple in its chemical and physical effects, and so trustworthy as to the amount of change produced and the permanency of the resulting negative, as the use of mercuric chloride followed by ferrous oxalate. The same advantages that we have indicated in connection with photographic "tabloids" apply also to the same firm's "'soloid' microscopic stains." A dozen or more varieties are already issued, the most recent addition being Leishman's modification of Romanowsky's stain for blood films. Microscopists will appreciate not only the convenience of being able to prepare staining solutions without having to weigh the solid substances, but also the fact that these preparations are made from materials specially selected for the purpose.

In *Science* for May 29, Mr. C. A. Chant discusses certain questions connected with theories of colour vision, and in particular a view put forward by Dr. Kirschmann according to which colour sensation may not be due to the effect of rays of one particular wave-length, but rather to the superposition of rays of different lengths the *combination* of which produces the effect of colour. That the theory in question is a possible one arises from the fact that "nobody

has seen light of one wave-length," and even in the narrowest band obtainable by a pure spectrum, differences of frequency amounting to many millions of wave-lengths may occur. Mr. Chant, on the other hand, refers to the experiments of Rowland, Michelson and Morley, Perot and Fabry in obtaining interference effects with very long differences of path (other experiments in this direction were recently noted in NATURE), and to the fact that not only was there no sign of the colour disappearing when the light approached perfect homogeneity, but the intensity of the sensation was slightly increased.

THE article on the infection-power of ascospores in the Erysipheæ is continued in the *Journal of Botany* (June) by Mr. E. S. Salmon. The ascospores of *Erysiphe graminis* growing on barley were found to be capable of infecting two allied species, but failed when sown on four other species of Hordeum, as well as on wheat, oats and rye. This establishes the existence of biologic forms in the ascospore stage similar to those known for the conidial stage. In the case of the form under investigation, the same species of Hordeum are proof against infection whether by ascospores or conidia.

THE announcement was recently made of the discovery of a new source of indiarubber, the peculiarity being that the latex, which has been found to yield a good marketable caoutchouc, is obtained from the underground portion of the tree, a Landolphia. The genus is confined to Africa, more especially to the tropical regions, and is characterised by the presence of latex in the stem, but the latex only furnishes caoutchouc in a few species. Of these the three best known, *Landolphia Kirkii, L. owariensis*, and *L. florida*, are llianes climbing by means of tendrils. Recently the new species *Landolphia Thalloni* has been exploited in the French Congo; the aërial portions of this species persist only for one or two seasons, and the latex is stored in the rhizome.

THE whole of vol. lxxiv. part ii. of the *Zeitschrift für wissenschaftliche Zoologie* is occupied by the first instalment of a dissertation, by Prof. A. Schuberg, on the nature of intercellular tissue. Among other results, it is demonstrated that the tissue between the cells of the epidermis is readily distinguishable from the corresponding structure in the true skin.

IN the April number of the *American Naturalist*, Prof. W. Patten describes certain fragmentary remains which, in his opinion, justify the conclusion that the primitive fish-like creature Trremataspis (previously known only by the dorsal shield) was furnished with a pair of oar-like swimming appendages attached to the head, and resembling those of Pterichthys and Bothriolepis. If this be so, it is probable that similar appendages likewise existed in Pteraspis, Cyathaspis, and Polyaspis.

IN an article entitled "The Ways of Nature," published in the June number of the *Century Magazine*, Mr. J. Burroughs discourses in a popular style on the question whether the lower animals really possess self-consciousness. Probably, he argues, they think without knowing that they think, and thus the faculty in question is restricted to man. Later on reference is made to incidents quoted in well-known works which seem to show that animals are really possessed of reasoning powers, but it is pointed out that since these incidents were, in most cases, at any rate, not recorded by trained scientific observers, their value must be largely discounted.

IN the report of the Marlborough College Natural History Society for 1902, the secretary states that, notwithstanding the season having been unfavourable for field-work, there are no reasons to be dissatisfied with the results of the year. The collections which have been most largely increased are those of the various groups of insects, especially Diptera. The members, it is stated, have been urged to specialise their studies, as it is considered that by this method the best results are ensured for future years. Whether this is really so there may, however, be two opinions.

ACCORDING to the annual report of the Cambridge Museums and Lecture Rooms Syndicate for the past year, considerable progress has been made in transferring the collections of the Woodwardian Museum to the Sedgwick Memorial Museum in Downing Street, where the geological lectures have been delivered. Amongst the more important additions to the University collections, special attention is directed to a valuable series of human skulls obtained from various sources, also to the skeleton of a humpback whale, presented by Mr. Rothschild, and to specimens of the whale-headed stork (*Balaeniceps rex*), the gift of Sir Reginald Wingate. During the twelvemonth the Zoological Museum has likewise been enriched by the gift, from Prof. Newton, of several collections of birds and eggs of exceptional value.

M. É. RECLUS has reprinted his interesting little book "Les Primitifs," which was originally published in 1885. The book is well known to English readers under the title "Primitive Folk: Studies in Comparative Ethnology" (The Contemporary Science Series); it deals with the Eskimo, Apaches, and various tribes of southern India. Nothing new has been added to the original edition.

DR. FRANZ BOAS has published as *Bulletin* 27 of the publications of the Bureau of American Ethnology the Tsimshian texts he collected at the mouth of the Nass River in 1894 while he was engaged in researches under the auspices of the British Association Committee on the North-western Tribes of Canada. By far the greater number of these are myths of the tribes in which the miraculous is blended with the actual; it is not difficult to eliminate the former. The remainder gives a good insight into the everyday life of the people. The texts are printed as they were taken down by Dr. Boas from his informants, and a literal word for word translation is given, as well as a more free rendering. In addition to their linguistic value these texts afford the reader a good idea of the literary style and the sentence-building of the Tsimshian Indians without a previous knowledge of the language being necessary.

A REPORT on the Kangaroo Hills Mineral Field, by Mr. W. E. Cameron, has been issued by the Queensland Geological Survey. The district is one of altered sedimentary rocks and granite, in which tin, copper, and silver mining has been carried out. A report on Yorkey's Gold Field and the Marodian Gold and Copper Field in the district of Wide Bay, Queensland, has been prepared by Mr. L. C. Ball. Yorkey's Gold Field lies in an area of slates assigned with doubt to the Gympie (permo-Carboniferous) formation, with intrusive masses of granite and diorite, and the auriferous quartz reefs occur in or adjacent to the diorite. The other districts referred to are in the prospecting stages. A report on the west coast of the Cape York Peninsula and on some islands of the Gulf of Carpenteria has been drawn up by Mr. C. F. V. Jackson. Interesting particulars and photographic views are given of

this little known region, including notes on the mangrove trees and their influence on the coast line. The gold-field of Horn Island is described, the reefs occurring in porphyritic granite. The works are now abandoned, but apparently they were started before adequate investigations had been made, and even now it is doubtful whether the trials were exhaustive.

WE have received a copy of the illustrated catalogue of chemical apparatus and laboratory fittings supplied by Messrs. Max Kaehler and Martini, of Berlin, W. The catalogue runs to 500 pages, and will be sent post free to schools and colleges where there are chemical laboratories. The sole agent for the United Kingdom is Mr. S. Bornett, 62 King William Street, London, E.C.

PROF. WYNDHAM R. DUNSTAN, F.R.S., was recently appointed by the Board of Trade to be director of the Imperial Institute, and one of the results appears to be the publication, as a supplement to the *Board of Trade Journal*, of a "Bulletin of the Imperial Institute." The first issue of the bulletin contains much useful information as to the experiments and inquiries which have been carried out in the scientific and technical department of the Institute. Reports on the following investigations, amongst others, are included:—poisonous fodder plants and food grains; analyses and examinations of coal from Trinidad; kaolin from St. Vincent; tin ore from the Bautshi tin fields, Northern Nigeria; fibres from Sierra Leone and Brazil; and nuts from British Honduras and Portuguese East Africa. The second part of the bulletin consists of general notices prepared by the scientific department on a variety of questions, as different as the chemical analysis of gutta-percha as a guide to its cultivation and valuation, and cotton cultivation in Asia Minor. The work of the scientific and technical department is chiefly initiated by departments of the Governments of India and the Colonies. Arrangements have been also made by the Foreign Office whereby British Consuls may transmit for investigation such natural products of the countries in which they are appointed to reside as are likely to be of use to British manufacturers and merchants. Materials are first chemically investigated in the laboratories of the department, which includes a staff of skilled assistants, and are afterwards submitted to technical trials by experts, and finally are commercially valued. Manufacturers, and dealers in natural products, ought to be keenly alive to the advantages to be derived from work and inquiries of this character.

THE additions to the Zoological Society's Gardens during the past week include an Indian Elephant (*Elephas indicus*, ♀) from India, presented by the Maharaja of Benares; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Mr. J. R. E. Stansfeld, D.S.O.; a Crested Porcupine (*Hystrix cristata*), a Black-backed Jackal (*Canis mesomelas*), a Puff Adder (*Bitis arietans*), a Cape Bucephalus (*Dispholidus typus*), a Smooth-bellied Snake (*Homalosoma lutrix*) from South Africa, presented by Mr. Barry McMillan; two Puff Adders (*Bitis arietans*) from South Africa, presented by Mr. A. W. Guthrie; two Black Lemurs (*Lemur macaco*) from Madagascar, a New Zealand Owl (*Ninox novae-seelandiae*), four Variegated Sheldrakes (*Tadorna variegata*) from New Zealand, five Nutmeg Fruit Pigeons (*Myristicivora bicolor*) from Moluccas, six Nicobar Pigeons (*Caloenas nicobarica*) from the Indian Archipelago, a Glossy Calornis (*Calornis chalybeus*), a Hamadryad (*Naia bungurus*) from India, seven Large Andaman Parrakeets (*Palaeornis magnirostris*), an Andaman Starling (*Poliopsar andamanensis*), six Andaman Teal (*Querquedula albigularis*) from the Andaman Islands, two Canadian Cranes (*Grus canadensis*), four Prickly Trionyx (*Trionyx spinifer*) from North America, four Ceylonese Terrapins (*Nicoria trijuga*) from Ceylon, two Adanson's Sternotheres (*Sternothoerus adansoni*) from West Africa, deposited; a Brush Turkey (*Talegalla lathami*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JULY:—

1. 10h. 40m. Minimum of Algol (β Persei).
5–6. Venus very near Regulus (α Leonis).
9. 8h. 4m. to 9h. 11m. Moon occults ρ' Sagittarii (mag. 3·9).
„ 15h. Venus at greatest elongation, 45° 30′ E.
15. Venus. Illuminated portion of disc = 0.459 of Mars = 0·873.
20. 13h. 56m. Moon in conjunction with Aldebaran (α Tauri).
21. 12h. 23m. Minimum of Algol (β Persei).
23. Mars 1½° N. of Spica (α Virginis).
24. 9h. 12m. Minimum of Algol (β Persei).
26. 8h. Moon in conjunction with Pallas. Pallas 0° 47′ N.
29. 20h. Saturn in opposition to the sun.
30. Uranus ½° N. of 51 Ophiuchi (mag. 4·9).

NEW COMET, 1903 *c*.—A Kiel Centralstelle telegram announces that M. Borelly, observing at Marseilles, discovered a new comet, 1903 *c*, on June 21. Its position for 11h. 36·5m. (M.T. Marseilles) on June 21 was

R.A. = 21h. 52m. 52s., Dec. = 8° 10′ south,

and its daily movements in R.A. and Declination are −28s. and +44′ respectively.

The telegram states that a nucleus and a tail have been observed, but it does not state the magnitude of the object.

A later telegram states that Herr Wirtz, Strasburg, observed this comet at 22h. 8·8m. (M.T. Strasburg) on June 22, and determined its position as follows:—

R.A. = 21h. 51m. 53·73s.
Dec. = 7° 17′ 11″ south.

PHOTOGRAPHIC OBSERVATIONS OF COMET 1902 III.—Prof. Sykora, of Jurjew, has communicated to No. 3871 of the *Astronomische Nachrichten* the results of the photographic observations of Comet 1902 iii. made by him during September and October of last year.

Reproductions of drawings made from the photographs show that on September 26 the comet possessed two tails of Bredichin's second and third types respectively, and the measurements showed that the longer tail was about 2° in length. On October 7 this length was increased to 3°, and the tail was more like Bredichin's first type, whilst the shorter third-type tail had decreased in length. On the photograph taken on October 9 this difference was further accentuated.

THE MIRROR OF THE CROSSLEY REFLECTOR.—Dr. G. Johnstone Stoney writes to correct a misapprehension referring to the mirror of the Crossley reflector in use at the Lick Observatory. The figuring of this mirror is usually attributed to the late Dr. Common, and has been ascribed to him in these columns (pp. 132, 162). It appears, however, from a correspondence between Mr. J. Gledhill and Prof. Campbell that Mr. Crossley's gift to the Lick Observatory included two mirrors, described as A and B, essentially of the same diameter and focal length. One of these, B, was refigured by Sir Howard Grubb, and was sent to America as it came from his workshop. "It is the B mirror," Prof. Campbell states, "which has been used in all the work with the Crossley Reflector at the Lick Observatory." Dr. Stoney adds:—"In any enumeration of noteworthy instruments made by Dr. Common, it would appear desirable to include the very remarkable flat mirrors of large size which he produced of late years, some of them for the cœlostats of the Joint Solar Eclipse Committee of the Royal and Royal Astronomical Societies. The production of

optically flat mirrors of such size and so great perfection was a very great achievement."

RADIANT POINTS OF JULY AND AUGUST METEORS.—A paper by Mr. Denning in No. 3874 of the *Astronomische Nachrichten* describes the meteor showers which occur about the same time of the year as the splendid Perseid shower, and it gives, in tabular form, the radiant points of more than one hundred showers that have been observed at Bristol, during 1876–1902, in the months of July and August, dividing the epochs of appearance into three periods, viz. July 6–16, July 20–August 16, and August 19–25. Many of the displays are feeble, and a prominent feature of these is that they appear for a long period from the same fixed radiant.

The Perseid swarm varies greatly in intensity; at some apparitions as many as 150 to 200 shooting stars are observed per hour, whereas at other appearances the hourly rate may decline to 20 or 30. From a careful survey of the records, Mr. Denning thinks that there is evidence of this shower having a periodicity of between 104 and 123 years. The maximum is now reached on the morning of August 12 or 13.

SUN-SPOTS AND TERRESTRIAL TEMPERATURE.—In discussing the statement recently made by M. C. Nordmann in its application to the temperatures observed at the Jacob camp (Guadeloupe), M. Alfred Angot finds that approximately the same law holds good, and may be represented by the formula

$$t = t_0 + ar,$$

where t is the actual temperature, r is Wolf's frequency number, and t_0 and a are constants for each station, a being a negative quantity. On calculating the temperatures for the Jacob station from this formula, first determining the constants for that place, it is found that they vary but slightly from the observed values, the mean variation being $\pm 0^\circ.06$ C., and M. Angot suggests that an analysis of the annual variations at a number of stations might reveal the presence of further periodical variations (*Comptes rendus*, No. 21).

THE SATELLITES OF SATURN.—*Bulletin* No. 34 of the Lick Observatory contains the results of a second series of observations of the satellites of Saturn made by Mr. W. J. Hussey of that observatory.

Mr. Hussey measured the position angles and distances of each satellite in respect to one of the others, and gives a table containing all the details of each observation; he concludes from estimations of their respective light values that Mimas is probably larger than Hyperion, and, from his measurements, that the generally accepted diameter of Titan is undoubtedly too large; 2500 miles is, according to him, a much nearer approximation to the true value than the values given in most text-books.

THE ROYAL SOCIETY CONVERSAZIONE.

MANY of the objects on view at the Royal Society conversazione on Friday last were shown at the gentlemen's conversazione held on May 15, and have already been described in these columns (p. 59). There was, however, a number of additional exhibits illustrating methods and results of recent work in many branches of science, and these are mentioned below.

The condensation of the radio-active emanations of radium and thorium by liquid air formed the subject of an exhibit by Prof. E. Rutherford, F.R.S., and Mr. F. Soddy. The radio-active emanations of thorium and radium appear to be the residues of the thorium atom and radium atom respectively after the heavy positively charged particles, known as the "α rays," have been projected. They have all the properties of inert gases of the argon family, and diffuse away from the radium and thorium compounds producing them. They can be condensed at the temperature of liquid air, and are again volatilised on raising the temperature. Their actual quantity is almost infinitesimally small, being quite invisible and unweighable, but their presence can be detected by their property of radio-activity.

A method for the rapid determination of the specific gravity of blood, taken from a single drop, was shown by Prof. W. J. Sollas, F.R.S. A fluid heavier than the blood (chloroform and benzole sp. gr. 1·07), and another lighter (benzole and chloroform sp. gr. 1·04), are introduced into a tube, the heavier first, so that the lighter, added subsequently, floats upon it. The two fluids mix by diffusion so as to produce a column in which the specific gravity varies continuously from a higher to a lower value upwards. A drop of blood obtained from a pin prick is then added, and sinks in the column until it reaches a level where the specific gravity is identical with its own. Two glass floats of known specific gravity are now introduced, one of higher and the other of lower specific gravity than the blood. The distances of these, when floating in the column, from the drop of blood are proportional to the difference in specific gravity.

Mr. J. Y. Buchanan, F.R.S., exhibited a copper sphere and brass tube in illustration of an effect produced by the momentary relief of great pressure. Experiments were made during the cruise of the *Challenger* and on board the *Princess Alice*. The copper sphere contained a glass spherical flask of about 1½ inches in diameter hermetically sealed, and the sea water had free access through the two holes at the poles. The brass tube contained a glass tube of 50 cubic centimetres in capacity, hermetically sealed, and the sea water had free access at both ends of the brass tube. The brass tube was sent to a depth of 3000 metres, and at some, probably less, depth the internal glass tube gave way to the pressure and collapsed suddenly. The enclosing brass tube was pinched up by the external pressure. The experiment shows that, in the time, it was easier to pinch the envelope of brass than to shove in the plugs of water at both ends. The copper sphere was sent first to 3000 metres, but was pulled up without showing any effect. It was then sent to 6000 metres, and the internal glass flask collapsed at some depth between 3000 and 6000 metres, and the creasing which is visible on the copper sphere was produced. These experiments, whether made with the copper ball or with the brass tube, furnish striking demonstrations of the importance of the element of *time* in all physical considerations.

Photographs of the paths of aërial gliders were shown by Prof. G. H. Bryan, F.R.S., and Mr. W. E. Williams. These photographs were taken by attaching a piece of magnesium wire to gliders of cardboard, and show the path taken during their descent through the air. By fixing a rotating wheel in front of the camera so as to give a series of exposures instead of a continuous exposure, dotted traces were obtained, the distance between the dots enabling the velocity at different points to be compared.

The solar disc in monochromatic (K) light was exhibited by the Solar Physics Observatory, South Kensington. The glass positive and negative shown was a specimen of one of the trial plates taken for adjustment of the new photo-spectroheliograph. Large belts of prominences could be seen stretching across the solar disc.

The Solar Physics Observatory also exhibited photographs of the spectrum of lightning. The spectra were secured by Dr. William J. S. Lockyer on the early morning of May 31. Small cameras were employed fitted with Thorpe's transparent gratings in front of the lenses.

A reproduction of the hydraulic organ of the ancients was shown by Mr. John W. Warman. This instrument, originally invented by Archimedes about 250 B.C., has furnished a problem for at least 600 years, and has been the subject of endless speculation. The only real difference between the hydraulic and the ordinary or "pneumatic" organ is that, in the former, the wind-pressure is derived from the weight of an annular mass of water, instead of from the loaded top of a folded air-bellows.

Mr. W. N. Shaw, F.R.S., had on view the July number of the Monthly Pilot Charts of the North Atlantic and Mediterranean, issued by the Meteorological Council. The chart was exhibited to show the modifications introduced since the commencement of the series in April, 1901.

Bactericidal emanations from radium were demonstrated by Mr. Henry Crookes, who also showed photographs of a box of instruments, (*a*) taken by ordinary Röntgen rays, (*b*) taken by radium emanations at a distance of eighteen inches.

Other subjects of exhibits belonging to the physical sciences were:—photographs illustrative of the Coronation Naval Review, 1902, Dr. W. J. S. Lockyer; the Cooper-Hewitt mercury vapour lamp of the British Westinghouse Electric and Manufacturing Company, Ltd., by Prof. Ernest Wilson; an automatic mercury vacuum pump, by Dr. S. R. Milner; (1) stereoscopic fluoroscope, (2) stereoscopic X-ray photographs, Mr. J. Mackenzie Davidson; detonation of small shells, Dr. O. J. Silberrad; (1) apparatus for obtaining monochromatic illumination with the microscope, (2) a new turbidimeter, for determining the turbidity of water, by Mr. Charles Baker; controlling and regulating spark discharges, experiments in illustration, by Mr. Alfred Williams.

Prof. E. B. Poulton, F.R.S., illustrated the protective resemblance of butterflies to dead leaves and fragments of dead leaves. A resemblance to entire dead leaves with midrib, traces of oblique veining, and often attacked by fungi, is found in many genera of tropical butterflies. Holes, when represented, appeared to have been gnawed by insects, &c. There are three stages in the representation of such holes:—(1) by opaque strongly reflecting "body colour"; (2) by transparent windows; (3) by actual apertures. In the Holarctic region, with its deciduous trees, a genus (Polygonia = Grapta) which is defended by the same kind of concealment resembles, not entire leaves, but weather-beaten and ragged fragments, and it is not a gnawed hole which is represented on the butterfly, but a curved crack due to chemical and mechanical changes in a dead leaf fragment.

The director, Royal Botanic Gardens, Kew, showed three interesting instances of plant adaptations, namely, (1) a sensitive orchid (*Masdevallia muscosa*) from New Grenada. The lip closes when an insect lights on it; the insect, in crawling out, is compelled to carry the pollen masses away with it. (2) A case of commensalism (*Dischidia rafflesiana*) from Java. Leaves become converted into bags which ants fill with soil; the plant sends roots into the "flower pots" thus formed. (3) A possible case of protective mimicry (*Mesembryanthemum Bolusii*) from South Africa. The fleshy leaves simulate the lichen-covered fragments of rock amongst which they grow.

An exhibit by Dr. D. H. Scott, F.R.S., and Prof. F. W. Oliver illustrated Lyginodendron and its seed Lagenostoma. Lyginodendron is a characteristic member of the Palæozoic group Cycadofilices, a group recognised as occupying an intermediate position between ferns and gymnosperms. Hitherto no certain knowledge of the reproductive organs of these plants has been available. A reinvestigation of the detached Coal-measure seeds belonging to Williamson's genus Lagenostoma has furnished evidence which leads to the conclusion that one of them (*Lagenostoma Lomaxi*) was borne by Lyginodendron.

Fossil vertebrata from the Fayûm, Egypt, were exhibited by the director, British Museum (Natural History). The most important of the specimens were portions of the skull of the remarkable horned mammal, Arsinoïtherium, from the Upper Eocene. Specimens of the upper and lower dentition of the primitive elephants Palæomastodon and Mœritherium were also exhibited; these showed that the teeth are comparatively simple, and that the premolars and molars are in use simultaneously as in the ordinary mammal. Remains of the elephant and antelopes associated with flint implements from the lake beds of the lake Birket-el-Kerun were also shown.

A chart representing the first results of experiments on the migrations of plaice in the North Sea was shown by the Marine Biological Association. The distances travelled by some of the fishes have been very great, amounting in one case to 160 miles in six weeks. The Association also had on view a new British species of the Polychæte family Sabellaridæ, and living representatives of the Plymouth marine fauna.

The following were also among the objects on view:—mounted specimen of newly-born Indian elephant (*Elephas maximus*), born in the Zoological Society's Gardens, showing the hairy nature of the skin, as in the mammoth, by the director, British Museum (Natural History). A series of spear-heads, manufactured by the existing Aborigines of the north-west territories of Western Australia, by Dr. Henry Woodward, F.R.S. Remains of fossil mammals from an ossiferous cavern of Pliocene age at Doveholes, near Buxton, Derbyshire, by Prof. W. Boyd Dawkins, F.R.S. Colour photographs of living insects to illustrate protective coloration and resemblance, by Mr. F. Enock. (1) Tail feathers from a common male pheasant, illustrating sexual transformation of plumage; (2) a wild duck bred in captivity showing a converse change, by Mr. S. G. Shattock and Mr. C. G. Seligmann.

During the evening Prof. E. B. Poulton gave an account of the discoveries of Mr. Guy A. K. Marshall upon the wet season and dry season forms of Rhodesian butterflies. Mr. Marshall has proved, in three cases, by breeding the one from the other, that butterflies which are entirely different in colour, pattern, shape, relation of upper side to under side of wings, and even habits, and the selection of a certain type of country, are only the summer and winter forms of one species. The winter forms are always the better concealed in these cases, probably because the butterfly passes a much larger proportion of its life in a state of complete repose.

The Bioscope Company gave a lantern demonstration illustrating the scientific and educational applications of the bioscope.

THE ENGINEERING CONFERENCE.

LAST week the Institution of Civil Engineers held the bi-annual engineering conference for the present year, under the presidency of Mr. John Clarke Hawkshaw, president of the Institution.

The proceedings commenced on the evening of Tuesday, June 16, when Mr. W. H. Maw, past-president of the Institution of Mechanical Engineers, delivered the eleventh "James Forrest" lecture in the theatre of the Institution, his subject being "Some Unsolved Problems in Engineering." We published an abridgment of Mr. Maw's address last week (p. 163). On the following day, Wednesday, June 17, the chief business of the meeting commenced, and was continued over the Thursday and Friday following. The conference was divided into seven sections, the members of which met in various rooms near the Institution house in Great George Street. These sections were as follow:—Section i., railways, chairman, Sir Guilford Molesworth; section ii., harbours, docks and canals, chairman, Sir Leader Williams; section iii., machinery, chairman, Dr. Alex. B. W. Kennedy; section iv., mining and metallurgy, chairman, Mr. E. P. Martin; section v., shipbuilding, chairman, Sir John I. Thornycroft; section vi., waterworks, sewerage and gasworks, chairman, Sir Alexander Binnie; section vii., applications of electricity, chairman, Mr. Alexander Siemens.

Before proceeding to the various section rooms, members of the congress assembled in the theatre of the Institution of Mechanical Engineers to hear an introductory address from the president of the Institution of Civil Engineers, Mr. J. C. Hawkshaw. The address alluded to the work done at past conferences, and subsequently referred to the Engineering Standards Committee, which had been organised by the Institution in conjunction with various other technical bodies. The subject of the education and training of engineers was also touched upon, and in connection with the Admiralty scheme of training, the president pointed out that a similar plan of operations was devised by the Institution for the admission of students and associate members. Referring to the pollution of the town by smoke, the president said that "neglect to deal with it is yearly costing the growing population of London a large sum, and a Royal Commission had been appointed to inquire into the subject." The problems of locomotion and transport, timber supplies, and motor-car traffic were also dwelt upon briefly.

RAILWAYS.

The section devoted to railways met on the first and second days of the meeting, five papers being read in all. The first paper was on "The Assimilation of Railway Practice as Regards Loads on Bridges up to 200 feet Span," the subject being introduced by Mr. A. Ross. It was pointed out that it was undesirable to carry standardisation

to such an extent as might tend to arrest advancement in type or design, although it was of the utmost importance that uniformity should be arrived at with regard to the loads to which such structures might be subjected. In the discussion it was suggested that loads on bridges were nearing a limit, as electric traction would probably come into use, and this would do away with the need for the heavy steam locomotive.

In a contribution on "The Design of Permanent Way and Locomotives for High Speeds," by Mr. J. C. Inglis, it was pointed out that the increase in train mileage of British railways was mostly on long distance traffic, which meant heavy trains with heavy axle loads hauled at a relatively high speed. For express running, up to 60 miles an hour, no curves should be less than 40 chains radius. Heavy rails gave smoother running, and 90 to 100 lbs. per yard was often the practice. Four-coupled engines, with the front wheels coupled and a bogie under the foot-plate, formed an undesirable class of engine for high speed running, whilst engines with single drivers, and only one axle in front and one behind, were likewise unsatisfactory, and plunged considerably, even on good roads. Equalising levers had much to recommend them, and recent practice had been in the direction of raising the centre of gravity of the locomotive.

Mr. W. J. Cudworth read an interesting paper on "Automatic Signalling," giving particulars of applications that had been made on the London and South-Western Railway and on the North-Eastern Railway. Mr. Jacomb-Hood, in the discussion, said he was convinced that automatic signalling had a great future before it.

Lieut.-Colonel Yorke, R.E., introduced the subject of "The Organisation and Administration of an American Railway," which he dealt with in some detail. He advocated the separation of the traffic or commercial department from the operating or working department, as followed in America, although unusual in this country. The value of keeping accurate statistics was dwelt upon during the discussion.

"The Relative Advantages of Overhead, Deep-level, and Shallow Subway Lines for the Accommodation of Urban Railway Traffic" was the subject brought forward by Mr. S. B. Cottrell, who discussed the respective advantages and disadvantages of the different systems.

HARBOURS, DOCKS, AND CANALS.

This section met on the first and last days of the congress, Wednesday and Friday, and five papers were read in all. The first paper was on "Dredging in New South Wales," Mr. C. W. Harley being the author. He pointed out that rivers were the natural means for conveying produce, and the New South Wales Government had expended considerable sums on improving its navigation. Particulars of the extensive plant that was used for this purpose were given.

The second paper on the list was "Dredging, with Special Reference to Rotary Cutters," by Mr. J. H. Apjohn. The value of hydraulic dredgers, and the results achieved on the bar of the Mersey and other rivers, were first referred to. In dealing with rotary cutters, the author pointed out that the form of the blades and the angle at which they were set, whether they were straight or spiral, and the openings between them at the bottom, were the points to be determined. Different descriptions of material needed different forms of cutters. These two papers were discussed together, Sir Leader Williams, Prof. Vernon Harcourt, Mr. Wheeler, Mr. Matthews, and others speaking. The question of "Foreshore Protection and Travel of Beaches" was next taken, the subject being introduced by Mr. W. T. Douglass. This matter was discussed at a conference at Norwich, held last January, and the author dealt with the various points raised in connection with the subject, such as direction of current, depth of water, effect of flood tides on the travel of the beach, angle and length of groynes, &c. In the course of discussion, Mr. Matthews pointed out that often the value of land reclaimed was not equal to the cost of saving it.

The other papers read in this section were "The Modern Equipment of Docks, with Special Reference to Hydraulic and Electric Appliances," by Mr. Walter Pitt; and "Recent Improvements in Canal Engineering," by Mr. Gerald FitzGibbon.

MACHINERY.

In the machinery section sittings were held on the Wednesday and Thursday. The first subject was introduced by Mr. Archd. P. Head, and was on "The Speed of Overhead and other Cranes as a Factor in the Economic Handling of Material in Working." The author favoured continuous current for crane work at 220 to 500 volts. He preferred this to alternate current on account of the greater starting torque and acceleration which it gave; although alternating current motors were efficient at full loads, they could only have a strong starting torque at the expense of efficiency. Continuous current also admitted of easier regulation, was cheaper in wiring, and could be stored in batteries to equalise a variable load. Series-wound motors automatically ran faster with lighter loads, and should be used coupled permanently to the gear. They could withstand 100 per cent. overload for short periods, and higher overloads momentarily, without damage. Motors running continuously with clutch connections to the gearing should be shunt-wound. Quick stopping could be achieved by an electric brake working on the armature shaft, operated by a weight or spring, and taken off by a solenoid in series with the motor. A somewhat lively discussion followed the reading of Mr. Head's paper, Mr. Tannett Walker and Mr. Ellington advocating the use of hydraulic cranes, although the latter allowed that electricity was the best source of motive power for overhead travellers.

A valuable paper by Mr. H. J. Marshall, "Gauges and Standards as Affecting Shop and Manufactory Administration," followed. The subject is one which does not well lend itself to being abstracted in a few words, but Mr. Marshall's paper is the more valuable because it represents actual experience in large works.

Mr. H. A. Humphrey's paper on "Internal Combustion Engines for Driving Dynamos" was also one of considerable interest, and attracted a good many of the electrical engineers from section vii. The author dealt with the large gas-engines which have quite recently come into use, and the design of which, unfortunately, we largely owe to the Continent, where the application of blast furnace gas to internal combustion engines has given an impetus to this branch of industry. The author stated that there were about fifty firms manufacturing large gas engines of 200 horse-power and upwards. The engines completed or on order numbered 515, having an aggregate capacity of 328,065 horse-power; of these, 398 engines were for dynamos, and gave collectively 206,805 I.H.P. The gas producer and gas engine constituted the cheapest means of generating electric power, where coal was the basis of energy, and the gas engine had proved quite trustworthy for driving alternators in parallel. He considered that ultimately the gas engine would entirely take the place of steam plant in large central electric stations. A long discussion followed the reading of this paper, in which the views of the author were upheld by some speakers. Dr. Kennedy (who occupied the chair), however, said that before he advised the application of internal combustion engines for the generation of electrical energy he would like to feel more confidence, or have more experience on the subject. Mr. Crossley and Dr. Hopkinson, who both spoke, gave some remarkable figures, showing the advantage of gas engines over steam engines in regard to economy.

"The Use of Petrol Motors for Locomotion" was the subject introduced by M. E. Sauvage, the well-known French locomotive engineer, who gave in detail the points that should be observed in designing a successful petrol motor. In the discussion, Mr. Aspinall and other locomotive engineers pointed out that though the single unit vehicle had advantages, and appeared very attractive at first sight, practical considerations militated against it, and where, in the past, the system had been tried, it had been abandoned sooner or later.

The chief feature in this section was the last paper read, which was on "Apprenticeship in Engineering Education," by Prof. J. D. Cormack. The subject is too long and too important to treat in a brief report of this nature. Prof. Cormack merely set forth the chief aspects of the question, without pretending to arrive at any conclusion,

leaving the latter task to the speakers in the discussion; of these there were no less than twenty-five. They included Sir W. H. White, Prof Kennedy, Colonel Crompton, Captain Sankey, Profs. Ayrton, Burstall and Capper, the Hon. R. C. Parsons, and Messrs. D. Drummond, A. F. Yarrow, E. B. Ellington, Bertram Hopkinson and Mark Robinson. Most diverse opinions were expressed by the various speakers, but it may be said generally that some system in which a college course would alternate with practical experience, in periods of greater or less duration, received acceptation. Sir William White, in closing the discussion, gave a promise that the matter would be considered by the council of the Institution of Civil Engineers, which would take into consideration what had been said in the section, as well as the proceedings before the Institution of Mechanical Engineers and the Institution of Naval Architects, both of which had had presented to them papers on this subject by Prof. W. E. Dalby, who recently made a tour in America and on the Continent to study this question.

MINING AND METALLURGY.

Seven papers were read in this section. The first taken was by Sir Thomas Wrightson, Bart., M.P., and Mr. John Morison, the subject being "Notes on Percussive Coal Cutters." Details of the machinery were given, the authors arriving at the conclusion that in America machine coal-cutting had been successful, but in this country, up to the present, almost the opposite experience had been the result of the adoption of machinery, the economy, except in special cases, being doubtful.

"Recent Improvements in Gold-mining Machinery on the Rand," by Mr. A. E. T. Lees, followed. He dealt with the labour difficulty and its effect on the introduction of labour-saving devices. Considerable progress has recently been made in surface works, as well as certain improvements in mining machinery generally.

Mr. J. H. Harrison read a paper on "Equalising the Temperature of the Blast for Blast-furnaces, and its Effect on the Melting Zone." He gave particulars of the practice followed in America for preventing "scaffolds."

"Notes on Steam-driven and Gas-driven Blowing Engines" were contributed by Mr. Tom Westgarth, who had no hesitation in saying that the gas engine generally was more suitable for blast-furnace work, provided always that the gas saved by the use of the gas engine could be readily employed.

The remaining three papers read in this section were:—"The Continuous Method of Open-hearth Steel-making," by Mr. B. Talbot; "Alloys of Iron, Nickel and Manganese," by Mr. R. A. Hadfield; and "The Dangerous Crystallisation of Mild Steel and Wrought Iron," by Prof. J. O. Arnold.

SHIPBUILDING.

Section v. had five papers before it. The first was by Mr. A. F. Yarrow on "The Comparative Merits of Drilling and Punching in Steel for Shipbuilding." The author gave particulars of the British Admiralty regulations, which require drilling in place of punching for light vessels. He had found by experience that this was a wise provision, although it had been objected to by some contractors. In the discussion which followed, it was allowed that a drilled hole was better than a punched hole for light vessels, such as torpedo craft. For merchant ships, however, the greater expense of the drilling might be objected to.

Mr. John List read a paper on "Screw Shafts," pointing out the severe effects set up in them by racing in light vessels. He referred to the growing use of nickel steel for propeller shafts.

Mr. A. E. Seaton also read a paper on "The Modern Express Steamer for Short Passages," whilst Prof. A. Rateau dealt with "Steam Turbines." Mr. H. H. West contributed a paper on "Harbour Dues and Charges."

WATER-WORKS, SEWERAGE AND GAS-WORKS.

Five papers also were read in this section. The first was by Mr. G. T. Beilby on "Smoke Abatement." The author looked forward to the spread of the internal combustion engine and electric transmission of power to produce a better state of the atmosphere in large towns. He also considered that the firing of steam-boilers with washed gas would prove advantageous.

The next paper read was by Dr. S. Rideal, and was on "Coal-gas Standards." The subject is not one that lends itself to compression. The same may be said of Prof. Percy F. Frankland's paper on "The Bacterial Treatment of Water and Sewage." The other papers read in this section were:—"Steam Turbine-driven Centrifugal Pumps for High Lifts," by Mr. C. W. Darley; and "The Raising of Water by Compressed Air," by Mr. Percy Griffith.

APPLICATIONS OF ELECTRICITY.

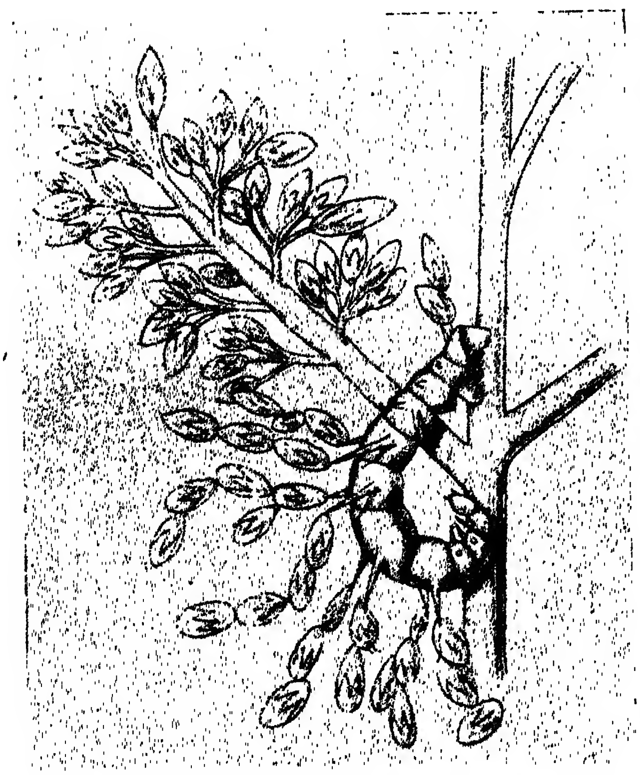
Five papers were read in section vii. The first was on "Wireless Telegraphy," introduced by Mr. E. A. N. Pochin, who gave a review of the principles involved in this subject and of recent developments. Among important facts which have lately been established are:—(1) up to considerable ranges earth-curvature is not a fatal obstacle, but hills may exercise a serious influence; (2) the ether exhibits what we may provisionally call a variable transparency to Hertzian waves, sunlight being an important factor. With regard to both these phenomena, it is probable that certain wave-lengths offer special advantages, whilst the second affords a faint clue to the relative share of earth and ether in transmission. Amongst problems, that of isolation is undoubtedly the most important, and in this direction two methods have been employed, which may be termed respectively syntonic and optical methods, both of which were described as regards performance and promise. During the discussion which followed, Mr. Gavey expressed the opinion that syntony in installations of wireless telegraphy of from 60 to 100 miles could be established, and maintained with certainty and regularity; but for long distances transmission was uncertain, owing to causes which were not apparent. The remaining papers read in this section were on the "Applications of Electricity to Driving Carriages in Towns," by Lieut.-Colonel R. E. B. Crompton, C.B.; "The Transmission and Distribution by Single-phase Alternating Current," by Mr. E. W. Monkhouse; "High-speed Electric Traction on Railways," by J. W. Jacomb-Hood; and "The Position and Protection of the Third Rail on Electric Railways," by Mr. W. E. Langdon.

NEW CASE OF PROTECTIVE MIMICRY IN A CATERPILLAR.

IT is well known that the larvæ of many insects, such as those of the case moths, clothes moths, caddis flies, tortoise beetles, and the masked bug, construct for themselves cases or artificial coverings either for protection or concealment, and a new and somewhat remarkable instance is described by Mr. R. Shelford, the curator of the Sarawak Museum, in the *Zoologist* for May. We are indebted to the publishers for the accompanying illustration of the caterpillar described.

On May 16, 1900, a native collector brought in a quantity of a Spiræa-like plant, intended for the food of butterfly-caterpillars. It bore numerous pale green cymose inflorescences which were still in bud, and presently one of the branchlets was noticed to be moving. This proved to be due to the presence of a small Geometer caterpillar (only 9 millimetres in length) covered with buds from the inflorescence on which it was feeding. This "bore the following spine-like processes, a dorsal pair on the 4th segment, a dorso-lateral pair on segments 5, 6 and 7, a lateral pair on the 8th segment, and a short dorsal pair on the 11th; there were also some small tubercles in the positions shown in the accompanying sketch." To these spines strings of buds, connected by silk, were fastened in a similar manner, and when the green buds faded, or were removed, they were immediately replaced by fresh ones. "A bud would be shorn off with the mandibles, then held in the two front pairs of legs, and covered all over with silk issuing from the mouth of the larva; the larva then twisted round the anterior part of the body, and attached with silk the bud to one of the spinous processes, and another bud would then be attached to this, and so on, until a sufficiently long string (generally three or four buds) was made, when operations on another spine would be com-

menced." The larva fed on the buds of the inflorescence, scooping out the interior, and (when not hurried) using the empty shells in preference to whole buds for its covering. "When irritated, the larva curled up in the attitude represented in the sketch, and it remained in this position for fifteen or twenty minutes." At other times it would sway about, looking like a branchlet blown by the breeze. The larva spun up on May 28, forming a silk cocoon covered with green buds, but it was, unfortunately, destroyed by ants, and as no other specimen could be discovered, it is



supposed that, as is well known to be frequently the case with specially protected insects, the species must be very rare. The perfect insect is, of course, at present unknown.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Harkness geological scholarship has been awarded to Mr. R. H. Rastall, Christ's, and the Wiltshire prize in palæontology to A. Blackie, Peterhouse, and H. H. Hodgson, Trinity, equal.

The Museum of Zoology has received an important addition through the bequest of the late Mr. T. E. Buckley, of Trinity College. The collections include some 440 volumes of books, and about 400 birds.

In the natural sciences tripos, part i., thirty men and one woman gain first classes. In part ii. thirteen men and one woman appear in the first class.

The Raymond Horton-Smith prize for the best M.D. thesis of the year is awarded to the Hon. G. H. Scott, Trinity.

At St. John's College the Hockin prize for experimental physics is gained by Mr. J. H. Field, late Lieut. R.E. The Adams memorial prize in astronomy is awarded to Messrs. Gold and Phillips, equal. The Hutchinson studentship for research in botany goes to Mr. R. P. Gregory, University demonstrator.

DR. A. F. DIXON, professor of anatomy in University College, Cardiff, has been appointed to the chair of anatomy in Dublin University, lately held by Prof. Daniel Cunningham.

MR. J. STUART THOMSON, lecturer on biology at the Municipal Technical School, Plymouth, has been appointed to the post of assistant to the Government Marine Biologist at the Cape of Good Hope.

DR. K. J. P. ORTON, demonstrator in practical chemistry at St. Bartholomew's Hospital Medical School, has been appointed professor of chemistry at the University College of North Wales, Bangor, in succession to Dr. Dobbie.

THE Massachusetts Institute of Technology has established a laboratory of physical chemistry to be opened in September, which is to be devoted exclusively to research work. The laboratory is to be under the directorship of Prof. A. A. Noyes, with whom will be associated Profs. H. M. Goodwin and Willis R. Whitney. The researches will be carried on in large part by a staff of research assistants and associates working under their direction. Every facility will also be offered to advanced students who wish to carry on investigations in this branch of science.

AN appeal for funds to extend the department of experimental and applied science and natural sciences is being issued by the University of Dublin. It is pointed out that the University of Dublin must either obtain external aid to build and equip laboratories and lecture rooms for physical science, electrical and mechanical engineering, botany and zoology, or teach these subjects under grave disadvantage. A full report, drawn up by a committee appointed by the board of Trinity College to consider the present scientific requirements of the college, shows that a sum of 100,000*l.* is needed to provide for the requirements of the scientific schools of the University. Owing to the generosity of Lord Iveagh, however, the appeal is reduced to a request for an increased income of 2700*l.* The entire capital outlay, 34,000*l.*, is undertaken by Lord Iveagh if the necessary income for upkeep is forthcoming within the next three years.

FOR a long time past the Merchant Venturers' Technical College, Bristol, though a large building, has been inadequate to meet the demands of the increasingly large number of adult day and evening students. Negotiations have, however, just been concluded by which an additional building will become available for the purposes of the college in September next. It is hoped to make provision in this new building for an extensive boot and shoe shop, and for new shops for printers, painters, bookbinders, and plumbers. In order that the new workshops may be fitted up with the latest improvements, the teachers of the college are to visit workshops of the same kinds in other towns. It is hoped also that the local manufacturers interested in the trades in question will be willing to contribute funds or apparatus. The total floor space in the new building will be close upon 12,000 square feet. The space available for the mechanical and the electrical engineering laboratories will be more than doubled. The present small hydraulic laboratory will be replaced by one many times larger, and a new large physical laboratory will be provided. Arrangements are being made to provide as early as the manufacturers can make them a large experimental steam engine, with two additional dynamos and all necessary measuring apparatus, at a cost of about 2000*l.*

THREE months ago, on March 26 (vol. lxvii. p. 500), a note was given of the gifts to science and higher education announced in *Science* for the preceding quarter. Since then the following benefactions have been published in our contemporary:—Harvard University has received two anonymous gifts, respectively 2000*l.* and 10,000*l.*, for Emerson Hall, to be erected for the department of philosophy, for which the necessary 30,000*l.* required has now been obtained; a fund of 2100*l.* has been subscribed to establish a lectureship in memory of Edwin L. Godkin; 2000*l.* for the establishment of a scholarship and 1000*l.* for the Semitic Museum by the will of Jacob A. Hecht; Mrs. John Markoe has given 1000*l.* to establish a scholarship in memory of her son; and the Harvard Club of Chicago has given 1000*l.* to found a scholarship in memory of Dunlop Smith. Mrs. Anderson has given 200,000*l.* to Barnard

College, Columbia University, to purchase the three blocks of land adjoining Columbia College. Mr. Joseph Pullitzer has given 3000*l.* for scholarships to the university. From the will of Dr. Thomas W. Evans, the City of Philadelphia will receive about 800,000*l.* for the "Thomas W. Evans Museum and Institute Society." Mr. John D. Rockefeller has offered to duplicate money raised by Acadia College, in Wolfville, N. S., up to 20,000*l.* before January 1, 1908; he has also offered to pay two-thirds of the cost of a building for the University of Nebraska to be used for social and religious purposes, on condition that the remaining third of the 20,000*l.* be contributed within about a year, and to give Denison College, Newark, Ohio, 12,000*l.* if the institution will raise a like sum by January 1, 1904, for the construction of additional buildings. Chicago Yale alumni give 500*l.* a year for the establishment of four Yale scholarships. Dr. Elizabeth L. McMahon left 1600*l.* to found a scholarship in Vassar College for daughters of deceased physicians. Colby University, Maine, receives 1000*l.* by the will of the late Robert O. Fuller, of Cambridge, Mass. The will of Mrs. Susan Bevier gives 10,000*l.* to the Rochester Athenæum and Mechanics' Institute. Mrs. Helen F. Ackley has left to Wesleyan University a bequest of 400*l.*, the income from which is to be used for the benefit of one or more women students. Mr. Andrew Carnegie has given 50,000*l.* for an extension of the Mechanics and Tradesmen's Institute, New York City. Dr. D. K. Pearsons has given Winter Park, Florida, 10,000*l.*, and Kingfisher College, Oklahoma, 5000*l.* The late Ario Wentworth, of Salem, Mass., left 20,000*l.* to the Massachusetts Institute of Technology. Mrs. Vail, wife of Prof. Vail, has given Hobart College 1000*l.* The late Walter D. Pitkins has bequeathed 2000*l.* to Yale University. Mr. Francis L. Stetson, of New York, has given 5000*l.* to Williams College. Mr. Robert C. Billings has given the same sum to Wellesley College. Mr. Henry Denhart, of Washington, Ill., announces a further gift of 29,000*l.* to Carthage College. He offers 20,000*l.* for the endowment fund providing that the same amount be raised in the college territory, half of the expense of any new buildings erected up to 10,000*l.*, and 5000*l.* cash.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 28.—"On the Adaptation of the Pancreas to different Foodstuffs." Preliminary Communication. By F. A. **Bainbridge**, M.B., M.R.C.P. Communicated by Prof. E. H. Starling, F.R.S.

The author's observations have been made in the hope of determining, first, whether the composition of pancreatic juice (as regards its enzymes) varies in response to the stimulus of different foodstuffs, and, secondly, by what means this adaptation is carried out. The enzyme studied was lactase, which converts lactose into galactose and dextrose, and the degree of inversion produced by the enzyme was estimated by Pavy's method.

It was found that when dogs were fed on milk for two or three weeks, their pancreatic juice contained lactase, whereas the pancreatic juice of adult dogs not fed on milk contained no lactase. It seemed clear, therefore, that a definite foodstuff—lactose—caused the pancreas to secrete an enzyme capable of producing (in the lactose) digestive changes; in fact, the pancreatic juice varied in composition with different diets. It is believed by Pawloff and others that this adaptation is carried out entirely by a nervous mechanism, and that a given food reflexly excites the pancreas to secrete a juice specially adapted for the digestion of that particular foodstuff, and Weinland has adopted this view as regards the lactase of the pancreas.

However, Weinland's observation that lactose injected subcutaneously did not cause the formation of lactase by the pancreas suggested to the author that the intestinal mucous membrane must be concerned in the production of lactase, and that possibly the process was chemical rather than nervous. The author found that when an extract of the intestinal mucous membrane of a dog fed on milk was injected into a second biscuit-fed dog, the pancreatic juice of the latter contained lactase. On the other hand, when a watery extract of the intestinal mucous membrane of a *biscuit-fed* dog was injected intravenously into a second biscuit-fed dog, the pancreatic juice of the latter contained no lactase. These results suggest that, in consequence of the action of the intestinal mucous membrane on lactose, some substance is formed which passes by the blood-stream to the pancreas, where it stimulates the latter to manufacture a specific enzyme-lactase. If this proves to be the case, the whole process of adaptation must be chemical rather than nervous.

"Hydrolysis of Fats *in vitro* by means of Steapsin." By Dr. J. **Lewkowitsch** and Dr. J. J. R. **Macleod.**

Experiments which one of the authors (J. L.) had made with lipase prepared from pig's liver had not led to a higher hydrolysis of cotton-seed oil than 3 per cent. A fresh series of experiments was, therefore, commenced jointly by the authors with steapsin. Preparations of steapsin were obtained by mincing 200 grams of fresh pig's pancreas and triturating it in a mortar with twice the bulk of water. The preparations were not incubated at the body temperature, as previous experiments had proved that steatolytically active preparations had lost considerably in steatolytic power by being kept at 37° C.

The experiments were carried out by triturating in a mortar varying quantities of the steapsin preparations with cotton-seed oil until an emulsion was obtained. Unless the preparation and the oil form a thorough emulsion, no action of the ferment can be expected. If the emulsions are allowed to stand, hydrolysis commences after a few days, and reaches in the course of a few weeks a very considerable amount. Hydrolysis up to 86 per cent. was obtained after a lapse of a few months in the case of cotton-seed oil. Lard has not given so high a percentage of hydrolysis, although the opposite result would have been expected, inasmuch as the consistency of lard favours the state of emulsion.

Steapsin does not seem to produce the reversible action which other enzymes have been shown to exert. So far, small quantities of acid or alkali do not appear to influence the action of the ferment.

The foregoing experiments prove for the first time that it can be demonstrated by the usual quantitative methods of fat analysis that steapsin is a very powerful fat-splitting ferment.

June 11.—"The Measurement of Tissue Fluid in Man." Preliminary Note. By George **Oliver**, M.D., F.R.C.P. Communicated by Sir Lauder Brunton, F.R.S.

The object of this preliminary note is to indicate a method by which the tissue fluid in man may be measured, thus enabling the observer to ascertain the conditions under which it is effused and disposed of.

In the course of some observations made with the view of eliminating tissue fluid as a cause of variability in the samples of blood obtained for examination, the author found that the rolling of a tight rubber ring over the finger from the tip to beyond the interphalangeal joints will, as a rule, considerably raise the percentages of the blood corpuscles and of the hæmoglobin. The author could not arrive at any other conclusion than that the ring not merely empties the vessels, but likewise clears away any tissue fluid present in the skin and subcutaneous tissues. The needle, in puncturing the capillaries, liberates a certain portion of lymph from the areolar tissue which surrounds them, and this dilutes the blood. When, however, both fluids have been dispersed as much as possible by the compression of the firm rubber ring, a puncture made just before removing the ring yields blood *per se*; for the blood instantly returns to the vessels, whereas an appreciable interval must elapse before the lymph reappears, or is exuded afresh. The author therefore inferred that the reading of the difference in the percentage of the corpuscles, or of the hæmoglobin, before and after the use of the ring, provides a measure of the tissue-lymph, and makes the study of the circulation of it in man possible.

This simple method having furnished somewhat unexpected results, the author accepted them at first with reserve; and, for some time, the data were allowed to accumulate, until at last it was quite apparent that they invariably fell into the same order. Inasmuch as the method did not provide results which were exceptional or erratic, or contradictory and unaccountable, trust on it became gradually established by the mere repetition of the observations.

A number of observations have been made on normal subjects leading a quiescent life, with comparative rest of the muscles; and on persons subjected to varying degrees of exercise, and to different temperatures and altitudes. In this note the author limits himself, however, to a statement of results obtained in the former class of subjects only.

The numerous observations which this inquiry necessitated on the corpuscles, and on the hæmoglobin, were made by the hæmocytometer tubes and the hæmoglobinometer, which were described by the author before the Physiological Society some few years ago (see *Journal of Physiology*, Cambridge and London, vol. xix. p. 15), and the specific gravity of the blood was determined by Roy's method. The blood-pressures (arterial, capillary, and venous) were read by the hæmodynamometer (*ibid.*, vols. xxii., xxiii.), and Hill and Barnard's sphygmometer, and Prof. Gärtner's tonometer, were also occasionally used in determining the arterial pressure.

Some of the general conclusions afforded by the observations may be thus epitomised:—

(1) The amount of tissue fluid varies at different times in the course of the day, and each variation is of short duration.

(2) The ingestion of food produces a rapid flow of lymph into the tissue spaces, which in an hour after the meals acquires its maximum development, and then it slowly subsides, and only ceases to be apparent after the lapse of from 3 to 4 hours.

(3) The digestive curve of variation always follows the same general type; the rise being rapid, the acme short, and the subsidence gradual. The variations were observed to follow this well-defined order in all the healthy subjects so far submitted to observation. The curve of variation is, therefore, rhythmical—the wave abruptly rising to an acme and then somewhat slowly subsiding.

The following are two examples:—

Example 1.

	Corpuscles per cent.		Diff.	Percentage of lymph.
Before the meal (breakfast)	99[1] / 103	(4,950,000 per c.mm.) / (5,150,000 ,,)	200,000	4
1 hour after ...	91 / 106	(4,550,000 ,,) / (5,300,000 ,,)	750,000	15
2 hours after ...	94 / 105	(4,700,000 ,,) / (5,250,000 ,,)	550,000	11
3 hours after ...	96 / 104	(4,800,000 ,,) / (5,200,000 ,,)	400,000	8
4 hours after ...	98 / 101	(4,900,000 ,,) / (5,050,000 ,,)	150,000	3

Example 2.

	Corpuscles per cent.		Diff.	Percentage of lymph.
Before the meal (dinner)	99 / 99	(4,950,000 per c.mm.) / (4,950,000 ,,)	None	0
1 hour after ...	91 / 108	(4,550,000 ,,) / (5,400,000 ,,)	850,000	17
2 hours after ...	94 / 106	(4,700,000 ,,) / (5,300,000 ,,)	600,000	12
3 hours after ...	104 / 104	(5,200,000 ,,) / (5,200,000 ,,)	None	0

(4) The amount of lymph is proportionate to the rise of the mean arterial and capillary pressures, and these pressures have been found to follow exactly the same prolonged rhythmical course after the ingestion of food as does the effusion of lymph.

The following example shows the agreement between the blood-pressures and the amount of lymph:—

	Percentage of lymph.	Mean arterial pressure.
Before the meal	None	100 c.mm. Hg.
½ hour after	10	110 ,,
1 hour after...	16	116 ,,
1½ hours after	8	108 ,,
2 hours after	5	105 ,,
3 hours after	None	100 ,,

[1] The figure on the first line represents the percentage of corpuscles before, and the figure on the second line that after, compression of the finger by the rubber ring.

The method devised for observing the capillary pressure is not quite so delicate for the smaller variations as could be wished, and the author hopes to improve it; but it is sufficiently definite to show that the capillary blood-pressure is raised throughout the digestive circulatory disturbance, and especially so at the acme of it, and falls again at the close of it. When the mean arterial pressure is 100 c.mm. Hg before a meal, as in the above example, the capillary blood-pressure will read 20 c.mm. Hg; and in an hour after the meal, when the arterial pressure rises to 115 c.mm. Hg, or so, the capillary pressure will rise to at least 30 c.mm. Hg. Though this is a large relative rise, the author's observations show that it is not less than this, and that it is often more.

Physical Society, June 12.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—Some experiments on shadows in an astigmatic beam of light, by Prof. S. P. **Thompson.** Two years ago Prof. Thompson showed before the Society some experiments on the shadows formed when a thin rod is placed in a beam of light which has passed through a tilted plano-convex lens. In those experiments the peculiar effects were chiefly due to the aberration known as coma. Following up his experiments, Prof. Thompson has investigated the shadows produced when a thin rod is placed in an astigmatic beam.—On a method of determining the viscosity of pitch-like solids, by Prof. F. T. **Trouton** and Mr. E. S. **Andrews.** The various methods which have been proposed for measuring viscosity meet with difficulties when it is attempted to apply them for the measurement of the viscosity of bodies such as pitch. To obviate some of these difficulties a method has been devised in which a constant torque is applied to a cylinder of the substance, and the relative rate of rotation of the ends is observed. From these and the dimensions of the cylinder, the viscosity can be calculated by means of a formula deduced in the paper.—The positive ionisation produced by hot platinum in air at low pressures, by Mr. O. W. **Richardson.** The experiments described in this paper were almost all made at temperatures so low that there was no appreciable negative ionisation. In examining the relation between the current from a positively charged hot platinum wire and the applied E.M.F. at low pressures, results were obtained which indicated that the value of the current fell off with time when the other conditions were kept constant. Further experiments showed that the current died away rapidly at first until it reached a steady value which only disappeared gradually.

Royal Astronomical Society, June 12.—Prof. H. H. Turner, F.R.S., president, in the chair.—The president announced the death of Dr. A. A. Common, and a vote of condolence with his relatives was put from the chair and passed by the meeting.—A letter (accompanying a paper on the present condition of the lunar theory) from Mr. **Nevill,** director of the Natal Observatory, was read, in which the writer stated that the reductions desired by Prof. Newcomb had already been made, and were awaiting publication at the Natal Observatory.—The secretary read a paper, by Prof. E. W. **Brown,** on the verification of the Newtonian law, which gave rise to a discussion in which Prof. Newcomb and others took part.—Mr. **Newall** exhibited and explained a series of slides from spectroheliographs of solar faculæ, &c., taken by a new method by Prof. G. E. Hale at the Yerkes Observatory, and Dr. Lockyer showed slides taken at South Kensington.—Mr. E. W. **Maunder** read a paper by himself and Mr. J. E. Evans on experiments as to the actuality of the "canals" observed on Mars. A drawing of the planet, showing no canals, had been placed before classes of boys at the Greenwich Hospital School, who were set to copy it. It was found that those closest to the original, and therefore able to see the actual detail, drew no canals, but those placed at a further distance made copies in which they delineated canals, in many cases almost exactly as they are represented in drawings by Schiaparelli and others. The author's conclusion was that the so-called "canals" were mainly the interpretation by the observer of faint markings just at the limit of visibility. It also appeared that observers were inclined to prolong into lines any projecting points on the edges of the Martian "seas," and also to draw hard lines at the boundaries of faint shades. Mr. Maunder was convinced that the boys employed in the

experiments were not biased by any knowledge of drawings of Mars showing "canals."—Dr. Johnstone **Stoney** read a paper on an examination of Mr. Whittaker's "undulatory explanation of gravity" from a physical standpoint.—Father **Cortie** read a paper on the spectrum of sun-spots in the region B to D.—Photographs of nebulæ in Auriga, by Dr. Max **Wolf** and Dr. Isaac **Roberts**, were shown on the screen.—A paper by Dr. **Lockyer** on a probable relationship between solar prominences and coronal streamers was taken as read, as well as a paper by Dr. A. W. **Roberts** on the relation between the light changes and orbital elements of close binary systems.—The president briefly noticed a paper by Mr. **Bellamy** on the positions of stars around Nova Geminorum, and also a paper of his own on the possible identity of the Nova with a small star that had been previously photographed by Mr. Parkhurst and Dr. Max Wolf. Prof. Turner concluded that this faint star was not precisely in the place of the Nova.

Zoological Society, May 26.—Mr. G. A. Boulenger, F.R.S., vice-president, in the chair.—Mr. G. A. **Boulenger**, F.R.S., read a paper on the collections of batrachians and reptiles made at Chapadá, Matto Grosso, during the Percy Sladen Expedition to Central Brazil. One species of reptile was described as new to science under the name of *Norops sladeniae*.—A second paper on the collections made at Matto Grosso was contributed by Mr. Edgar A. **Smith**. It contained an account of the shells of the family Bulimulidæ, which was referable to three species.—A communication from Mr. F. F. **Laidlaw** dealt with the collection of acotylean polyclads made by Mr. Cyril Crossland in Zanzibar in 1901–02. Specimens of nine species were contained in the collection, eight of which proved to be new.—Mr. W. **Bateson**, F.R.S., read a paper on the inheritance of colour in fancy rats and mice, in which he gave an account of the work already published relating to the subject, and communicated new observations. The author analysed the evidence at his disposal, showing how far it conformed to Mendel's principles of heredity, and stated the difficulties which were encountered in attempting to apply those principles to certain of the specific results already witnessed. It was hoped that the chief colour-types might be figured in order to promote uniformity of nomenclature.

Geological Society, May 27.—Mr. E. T. Newton, F.R.S., vice-president, in the chair.—An experiment in mountain-building, by the Right Hon. the Lord **Avebury**, P.C., F.R.S. Various observers have endeavoured to throw light on the origin of mountains by compressing pieces of cloth, &c. In these cases, however, the pressure was only in one direction. The author wished to obtain a method of producing compression in two directions at right angles to one another; and, accordingly, he had an apparatus constructed consisting of four beams of wood, which could be approximated by means of screws. In the space, 2 feet across and 9 inches in depth, were placed pieces of carpet-baize and layers of sand, each about 1½ inches deep. The beams were then caused to approach one another until the sand rose in the centre into contact with the glass cover, against which it was flattened out. Casts were made of the surfaces of the different baize-layers, and it was found that in the lower layers the ridges were narrower, shorter, more precipitous, and more broken up than in the higher layers. A second series of casts was exhibited, with the sand and baize having been arranged as before, but with the weight placed on one side. The ridges followed the edges, though not closely, leaving a central hollow. There was a difference between the higher and lower layers, similar to that seen in the first experiment.—The Toarcian of Bredon Hill (Worcestershire), and a comparison with deposits elsewhere, by Mr. S. S. **Buckman**.—Two Toarcian ammonites, by Mr. S. S. **Buckman**. Two ammonites, belonging to the family Hildoceratidæ, found by members of the Cotteswold Naturalists' Field Club, are described and named.

Linnean Society, June 4.—Mr. G. S. Saunders in the chair.—Mr. F. N. **Williams** showed a series of 100 drawings of British Compositæ, 20 being Hieracia, drawn in pen-and-ink by Mr. E. W. Hunnybun, of Huntingdon.—Mr. George **Massee** showed a remarkable felted lining of fungus mycelium of a Polyporus taken from the interior of the node of a bamboo; the specimen belonged to Sir D. Brandis.—Colonel George **Colomb** sent for exhibition a fragment of a branch of a thorn from Hyde Park. This branch shows the mischief done to thorns near London by the larvæ of what had been identified as belonging to the wood leopard moth, *Zeuzera Æsculi*, Linn. The house sparrow was stated to destroy numbers of the perfect insect on their emergence.—Sir Dietrich **Brandis**, K.C.I.E., F.R.S., showed herbarium and museum specimens, from Kew, of *Gelsemium elegans*, Benth., a plant possessing powerfully poisonous properties.—On the anatomy and development of *Comys infelix*, Embleton, a Hymenopterous parasite of *Lecanium hemisphericum*, by Miss Alice L. **Embleton**. The only paper already published on this subject is that by Bugnion on the anatomy, development and habits of an allied fly (*Encyrtus fuscicollis*) parasitic in a caterpillar; there are numerous omissions in the results he records. The present paper also leaves points unexplained, but the author has been able to add some valuable facts to the knowledge upon the subject, the insect on which she has worked being *Comys infelix*, a new species.—Notes on the transition of opposite leaves into the alternate arrangement: a new factor in morphologic observation, by Mr. Percy **Groom**. The author stated that his observations began on *Atriplex rosea*, and to make a graphic representation of results, he plotted the length of the internodes in a given manner, which produced a regular curve; when this principle was applied to Chenopodium and Salsola an entirely different result came out, and a zigzag course was plotted, due to the long and short internodes alternating; at first he suspected this might be due to its nearness to salt water, but inland specimens told the same tale, and neither the influence of day and night nor of salinity could account for it. His belief was that the fusion of branch and stem was the true solution, for axillary branches are given off, but without visible traces of the fusion which does exist; in Salicornia, for instance, the leaves are fused up to the next node above. Observations have been made with a number of other plants as regards the arrangement of leaves and inflorescence.

PARIS.

Academy of Sciences, June 15.—M. Albert Gaudry in the chair.—On the conditions afforded for astronomical observations at the observatory of the Pic du Midi, by MM. B. **Baillaud** and H. **Bourget**. Preliminary experiments with three telescopes showed that this observatory forms an excellent station for astronomical observations.—On the existence of solar radiations capable of traversing metals, wood, &c., by M. R. **Blondlot**. The rays previously discovered by the author in the radiations from an incandescent mantle, and named by him the *n* rays, are now shown to be present in sunlight. Their property of increasing the luminosity of feebly phosphorescent substances was utilised as a means of detection.—On the problem of transformation in Taylor's series, by M. L. **Desaint**.—On the integrals of linear partial differential equations, by M. J. **Le Roux**.—On the barometric formula of Laplace, by M. L. **Maillard**.—On the diurnal period of the *aurora borealis*, by M. Charles **Nordmann**. The intensity of the aurora is regarded as due to two factors, the intensity of the solar Hertzian waves, and the degree of ionisation of the atmosphere. The ionisation being produced by the action of the violet and ultra-violet rays, and recombination occurring during the night, the conclusion is drawn that the diurnal period of the aurora ought to be characterised by a maximum in the early hours of the morning, and this is in agreement with the observed facts.—On the generalisation of a theorem of M. Boucherot, by M. R. **Swyngedauw**.—The wave-length of the *n* rays determined by diffraction, by M. G. **Sagnac**. The refractive index for quartz for the *n* rays, given by M. Blondlot as 2·942, is confirmed; the wave-length in air is about 0·2mm., or about four times the wave-length of the longest infra-red waves discovered by Rubens.—The classification of liquids and crystals from the magnetic point of view, by M. Georges **Meslin**.—The conditions which determine the sense and magnitude of electrification by contact, by M. Jean **Perrin**. The action of H and OH ions is very great in electrical osmosis, so much so that osmosis indicates their presence with a sensibility which

may even surpass that of coloured indicators.—On the prediction of barometric variations, by M. Gabriel **Guilbert.** It has been shown that the velocity of the wind does not always correspond with the barometric gradient. These cases are called abnormal, a normal wind being defined as one which is light for a gradient of 1mm. per geographical degree, moderate for 2mm., strong for 3mm., and violent for 4mm. The study of abnormal winds has led to deductions which may be utilised practically.—On a method of crystallising slightly soluble bodies, by M. A. **de Schulten.** Dilute sulphuric acid, added to a hot dilute solution of barium chloride at the rate of 0·1 mgr. per minute, gave after a month measurable crystals of barium sulphate. Crystals of anglesite and celestine can be obtained similarly, and the method has been successfully applied to the production of several other minerals.—On the substitution of paints having zinc for a basis in the place of lead paints, by M. J. L. **Breton.**—On the so-called colloidal silver, by M. **Hanriot.**—On the fusibilities of mixtures of sulphide of antimony and sulphide of silver, by M. H. **Pelabon.** The fusibility curve of a mixture of the sulphides of antimony and silver can be constructed completely; it presents two maxima corresponding to the existence of two definite combinations, $Sb_2S_3.Ag_2S$ and $Sb_2S_3.3Ag_2S$. It shows besides three minima corresponding to three different eutectic mixtures.—On the etherification of sulphuric acid, by M. A. **Villiers.** The limits observed in the case of some mixtures of alcohol with sulphuric acid of different strengths after standing twenty-five years at the ordinary temperature are practically identical with those attained by the same mixtures after 221 days at 44° C., or 154 hours at 100° C.—On some derivatives of aminopyromucic acid and furfuranamine, by M. R. **Marquis.**—The action of phosphorus trichloride upon glycerol, by M. P. **Carré.** PCl_3 acts upon glycerol in the same manner as with glycol. The compounds $P_2O_6(C_3H_5)_2$ and $P(OH).O_2C_3H_5Cl$ are immediately decomposed by water, giving $P_2(OH)_4.O_2.C_3H_5.OH$ and $P(OH)_2.O.C_3H_5(OH)Cl$, the calcium salts of which were isolated.—The action of hydrogen sulphide upon methyl-ethyl-ketone, by M. F. **Leteur.** The compound $(C_4H_8S)_3$ has been isolated, which can be regarded as a polymer of an unknown butanethione.—On two new hydrocarbons isomeric with campholene and camphene, by MM. L. **Bouveault** and G. **Blanc.**—The synthesis of 2:2-dimethylglutaric acid, by M. E. E. **Blaise.**—On formic acid from the air, by M. H. **Henriet.** In a previous note the author has indicated the existence in the air of a nitrogen compound with an acid which appeared to be formic acid. The substance has now been isolated in larger quantity, and the identity of the acid with formic acid completely proved.—The distribution of some organic substances in the geranium, by MM. E. **Charabot** and G. **Laloue.** The terpene compounds of the geranium are almost entirely localised in the leaves.—Observations on phenylglycollic acid, by M. Œchsner **de Coninck.**—The action of iodine bromide on albumenoid materials and on the organic nitrogen bases, by M. A. **Mouneyrat.** Iodine bromide forms addition compounds with many substances containing nitrogen, and is not necessarily a test for the existence of the pyridine ring in the molecule.—On the presence of indoxyl in urines, by M. L. **Maillard.** A reply to a note on the same subject by M. J. Gnezda.—On some peculiarities observed in the renal tubes of *Barbus fluviatilis*, by M. J. **Audigé.**—On a criterion of irreducibility in statistical data, by MM. Charles **Henry** and Louis **Bastien.**—New expression of the law of electrical stimulation, by M. and Mme. L. **Lapicque.** The formula given by Weiss, $vt=a+bt$, where v is the voltage, t the time, and a and b constants, is found to be only roughly approximate; the experiments of the author require a term with an additional constant to be added to the formula of Weiss.—On some nuclear phenomena of secretion, by M. L. **Launoy.**—Cerebral inertia relating to the reading of printed letters, by MM. André **Broca** and D. **Sulzer.**—Observations on the treatment employed for the destruction of Pyralis of the vine, by M. Joseph **Perraud.**—New researches on the epiplasm of the Ascomycetes, by M. A. **Guilliermond.**—Researches on the nutrition of the tissues in galls, by M. C. **Houard.**—On the cave of Font-de-Gaume, and on the age of the cavern, by M. E. A. **Martel.**—On a living safety lamp, by M. Raphael **Dubois.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 25.

UNIVERSITY COLLEGE MATHEMATICAL SOCIETY, at 5.30.—Some Present Aims and Prospects of Mathematical Research: E. T. Whittaker.

FRIDAY, JUNE 26

PHYSICAL SOCIETY, at 5. (University of London, South Kensington).—(1) Electrical Effects of Light upon Green Leaves; (2) Blaze-Currents, (*a*) of a Vegetable Tissue, (*b*) of an Animal Tissue; (3) Quantitative Estimation of Chloroform Vapour in Air by (*a*) Oil Absorption, (*b*) Densimetry: Dr. Waller.—The Temperature Limits of Nerve-Action in Cold-blooded and in Warm-blooded Animals: Dr. Alcock.—(1) On the Movement of Unionised Bodies in Solution in an Electric Field; (2) On the Passage of Nervous Impulses through the Central Nervous System: Dr. Hardy.

TUESDAY, JUNE 30.

SOCIETY FOR THE PROMOTION OF HELLENIC STUDIES, at 5.—Annual Meeting.

FARADAY SOCIETY (Rooms of the Chemical Society, Burlington House), at 8.—The Present Position of the Theory of Electrolysis: W. C. Dampier Whetham, F R S.—Chlorine Smelting, with Electrolysis: J. Swinburne.—Total and Free Energy of the Lead Accumulator: Dr. R. A. Lehfeldt.—Electrolytic Apparatus: Dr. F. Mollwo Perkin.

THURSDAY, JULY 2.

INSTITUTION OF MINING ENGINEERS, at 11 a.m.—Luxemburg and its Iron-ore Deposits: J. Walter Pearse.—The Lake Superior Iron-ore Region: Prof. Van Hise.—Mineral Resources of the State of Rio Grande do Sul, Brazil: H. Kilburn Scott.—Electric Coal-cutting: W. E. Walker.—Pneumatic and Electric Locomotives in and about Coal-mines: A. S. E. Ackermann.—Electrical Plant Failures, their Origin and Prevention: A. C. Cormack.—The Electrical Driving of Winding-gears: F. Hird.—Electric-power Distribution by Continuous Current for Mining and General Purposes in North Wales: T. P. Osborne Yale.

RÖNTGEN SOCIETY, at 8.30.—Annual General Meeting.

FRIDAY, JULY 3.

INSTITUTION OF MINING ENGINEERS, at 11.30 a.m.—Further Remarks on the Portuguese Manica Gold-field: A. R. Sawyer.—Coal-fields of the Faröe Islands: E. A. Greener.—Miners' Anæmia or Ankylostomiasis: Dr. J. S. Haldane.—Water-softening Plant: Vincent Corbett.—The Redevelopment of the Slate-trade in Ireland: O. H. Kinahan.—The Smelters of British Columbia: W. Denham Verschoyle.—The Common-sense Doctrine of Furnace-draught: H. W. Halbaum.—The Ventilation of Deep Mines: Arthur C. Murray.

CONTENTS.

THURSDAY, JULY 2, 1903.

THE BIOGRAPHY OF HELMHOLTZ.

Hermann von Helmholtz. By Leo Koenigsberger. In three volumes. Vol. i. Pp xi+375. Price 8 marks. Vol. ii. Pp. xiv+383. Price 10 marks. Vol. iii. Pp. xi+142. Price 3 marks. (Brunswick: Vieweg, 1903.)

I.

Education and Physiological Work.

THE third and last volume of Koenigsberger's biography of the great natural philosopher has now appeared. The whole work is worthy of its subject; the author made it his aim, as he tells us in his preface, to set forth Helmholtz's manifold and various achievements as a discoverer in such a way as to render them intelligible to all scientific readers. Helmholtz is best known by his discoveries in experimental physics, but during the first half dozen years after the completion of his professional education, the business of his life was that of an army surgeon. It was as an army surgeon that he published, between 1842 and 1848, those remarkable researches on fermentation, on the nature of muscular contraction, and on the production of heat therein, the results of which served as the foundation for the building up of a new science of physiology. Even the treatise on the "Erhaltung der Kraft," or, as we now call it, the conservation of energy, although mainly physical, exercised its chief influence on physiologists. In natural philosophy the principle set forth in it had been already recognised, but had not as yet been presented to the physiological student as a fundamental doctrine, or successfully applied to the phenomena of life.

The biography of a man of great intellectual pre-eminence fulfils its highest purpose by enabling us to form a just estimate of the antecedent and surrounding influences which made him what he was. Herr Koenigsberger has treated his subject in such a way as to afford the information that the scientific reader seeks. How can we account for the production of a man of such extraordinary endowments? Did Helmholtz owe his intellectual superiority to his innate qualities, to his parentage, to his education, and if to the latter, was it due to his teachers or to his contemporaries? Koenigsberger's indications lead us to believe that in each of these respects his life was influenced by circumstances exceptionally favourable to his intellectual development.

Nationally, Helmholtz was of mixed descent. It may be assumed that his father was German, but his mother was half English, half French. Her maiden name, Caroline Penn, was derived from the great Quaker of the seventeenth century, who himself was the son of an almost equally distinguished English admiral. On the female side she was of Huguenot descent.

There can, I think, be no doubt that the moral and intellectual atmosphere of the Helmholtz home was excellent. The little that we are told of his mother indicates that she was a woman of great simplicity of character, but at the same time of unusual intelligence, who devoted herself heart and soul to promoting the happiness of her husband and children. His father was at the head of the Gymnasium at Potsdam, a position which he had attained after many years of arduous struggle with adverse circumstances. He appears to have been an enthusiastic teacher, who made it his aim rather to evoke in his pupils a love for the classical writers than to drill them in grammatical niceties.

Of Helmholtz's childhood we are told that, although his mother recognised in her firstborn "Geist und Verstand," there was no other indication of infantile precocity. At nine he entered the lowest class in the Gymnasium, but in a year was half-way up the school. His progress, however, was retarded by the difficulty which he had in learning anything by heart. During his first three years he went through the regular classical work of the school, but he appears even at this early age (ten to thirteen) to have done much extra work under his father's direction, who encouraged him to extend his studies beyond the limits of the school course. At thirteen he began the study of mathematics under a teacher who appears to have had as great a faculty for exciting enthusiasm for work in natural science as the father had in literature. Helmholtz continued his classical work, but became more and more engrossed by his studies in mathematics and physics, the subjects which, he says in his "*Abiturientenvita,*" "omnium disciplinarum maxime a pueritiâ me delectavit," so much so that when the rest were engaged in construing, he "beguiled the tedious hour" by working problems "under the table." By the time he was fifteen, he had already made up his mind to devote his life to natural science.

His father's means were so limited that the only way in which this desire could be gratified was by taking the study of medicine "into the bargain." He therefore at sixteen, while still a "gymnasiast," became a pupil in the Friedrich-Wilhelm-Institut at Berlin (the Pépinière) for the training of army medical officers. Two years later (at eighteen) he passed the *Abiturienten-Examen*, showing "comprehensive and thorough knowledge in the elements of mathematics and physics." He obtained at the same time distinction in classics, exhibited a good knowledge of French, English, and Italian, and had made sufficient progress in Hebrew to be able to offer that language as an extra subject. It was thus that he was equipped for the business of his life. That he possessed extraordinary natural endowments cannot be questioned, but it is no less certain that he owed the early maturity of his intellect and his exceptional heuristic power to an almost perfect education.

Whatever be the place among contemporary physicists to which his achievements entitled him, it can scarcely be questioned that as a physiologist he was *primus inter pares*. He was the first to understand what is meant by the well-known definition of life as "organism in action," and thus to distinguish clearly between that branch of the science of life which deals with organism and that which relates to the chemical and physical processes by which its action manifests itself. In the former Helmholtz did not much interest himself, and consequently was not, in the modern sense of the word, a biologist. His aim

was not to inquire *why* the animal (or plant) body assumes in its development the characters which it presents to the naturalist, but rather to discover in what processes vital action consists, and to prove that these processes are identical with those of inorganic nature, and can only be investigated by the methods of exact science. But Helmholtz was far from supposing that these methods could be applied either to organism and its evolution or to the study of mental processes, and expressed his distrust of the efforts made by others in this direction, with perhaps too great contempt.

Helmholtz's professional education began when he left school in 1838, and occupied four years. It is noteworthy that, notwithstanding the almost incredible amount of work which was imposed on the students of the Pépinière by a curriculum which not only included anatomy, physiology, pathology, and practice, and the sciences then regarded as ancillary to medicine, but also logic and metaphysics, ancient history, and modern languages, Helmholtz still found leisure for other pursuits. He was not only able to obtain that mastery of music of which he was afterwards to make so splendid a use, but also to pursue without any assistance, except such as he derived from books, the higher branches of mathematics, in the elements of which his schoolmaster (Meyer) had so thoroughly grounded him.

It need scarcely be said that during this period of ceaseless exertion he became intimate with the greatest of his teachers, J. Müller, and thus, as he said himself, had another opportunity of observing "wie die Gedanke selbstständiger Köpfe sich bewegen." This intimacy was, no doubt, of great value to him, but there is no sufficient ground for the conjecture which has often been made that it was from Müller that he derived his inspiration. The two men were cast in such different moulds that this was scarcely possible. The subject which Helmholtz selected for his Latin graduation essay ("The Structure of the Nervous System in Invertebrates") was no doubt suggested by Müller, but Helmholtz was no sooner himself free ("selbstständig") than he followed his own bent. It seems probable that, even when he was working assiduously with Müller as a biologist, he anticipated the direction in which his future studies would lead him, and was already aware that physics and chemistry, not biology, would afford him effectual methods of research.

Helmholtz graduated in 1842, and soon entered on his duties as a military surgeon. These happily gave him sufficient leisure for his scientific work. His first research, of which the results were published in Wagner's "Handwörterbuch," was on the relation between the work done and the heat produced in muscular contraction. It was important as setting forth one of the fundamental facts on which the new science was to be built, and as preliminary to the treatise on the "Erhaltung der Kraft," which appeared two years later. Of the genesis of this work Koenigsberger gives an interesting account. The introduction to it was written in 1846, the very same year in which, at the age of twenty-five, he passed his final *Staatsexamen* as a practitioner of medicine and surgery, his examiners possibly little guessing whom they had before them. The manuscript of the introduction was put for friendly criticism into the hands of du Bois-Reymond, who, however, would make no change in it, regarding it as an "historisches Document für alle Zeiten." It was forthwith communicated to the recently founded Physical Society of Berlin, the young and active members of which thus became acquainted with the law of the conservation of energy long before it had been discussed by academicians. By the Physical Society it was received with enthusiasm, but when offered to Poggendorff for publication in the *Annalen*, he declined it as being too theoretical, promising, however, to accept it as soon as experimental proofs were forthcoming.

The four years during which Helmholtz was charged with regimental duties were so productive that, in 1849, when a vacancy occurred in the University of Koenigsberg, he was selected by the Minister of Public Instruction among the four whom J. Müller had recommended, namely, Ludwig, Helmholtz, du Bois-Reymond, and Brücke, as the men most capable of advancing science in the "physico-physiological direction." All of these men, whose claims Müller estimated to be equal, were young, but Ludwig was the senior, and would have received the appointment had not a suspicion of radicalism, wholly unfounded, attached to him. So Helmholtz became, at twenty-eight, professor of physiology with the magnificent salary of 120*l.* a year!

Helmholtz's removal to Koenigsberg was followed by a period of astonishing fruitfulness in discovery. The first new subject to which he directed his attention was that of the measurement for physiological purposes of extremely short intervals of time, and the application of these methods to the determination of the rate of transmission in nerve. This he accomplished with such completeness and exactitude that his results can, even now, be accepted without question. In the meantime he continued those studies in physiological optics which led to the discovery of the ophthalmoscope. This, as well as the subsequent discovery of the mechanism of accommodation of the eye for distance, was communicated to the Physical Society. Then followed an investigation of the time-relations of induction currents, a research of great importance in the technique of experimental physiology. His first researches on colour-vision were published in Poggendorff's *Annalen* in 1852, in which journal also appeared, about the same time, another research of great value in its bearing on electro-physiological questions—an investigation of the "distribution of currents in bodily conductors."[1] It was towards the end of the Koenigsberg time that Helmholtz made his first visit to England. In his letters home he refers with evident pleasure to his intercourse with English physicists, and especially to the impression made upon him by Faraday's "herzgewinnendes Wesen," and observed with great interest how "old bits of wood and wire" sufficed him for the

[1] See vol. i. p. 177.

making of the greatest discoveries. He no less highly appreciated the friendly welcome given him by the Astronomer Royal, Airy, and the opportunity of exploring Greenwich Observatory, and of seeing in operation the first successful method of recording photographically the readings of magnetic and meteorological instruments. With Thomson, Helmholtz did not come into personal relation until August, 1855, when they met at Kreuznach. Helmholtz describes (in a letter to his wife) his astonishment when a man whom he knew as one of the first of living mathematical physicists appeared to him as a "Jüngling von ganz mädchenhaften Aussehen," but possessed of a degree of acuteness, clearness, and versatility which he had never before met with. It can well be imagined how these two young discoverers must have enjoyed and profited by the exchange of thought on fundamental questions which each of them had done so much to elucidate.

The same year Helmholtz accepted the chair of anatomy and physiology at Bonn, his motive for doing so being that his wife, whose health was precarious, might have the advantage of a milder climate. At that time the two subjects were still united, so that Helmholtz was obliged to resume the teaching of descriptive anatomy. This drawback was, however, of short duration, for two years later he was invited to Heidelberg, where the conditions were much more favourable. Notwithstanding the onerous nature of Helmholtz's professional engagements, the fifteen years of his residence at Bonn and Heidelberg were almost as productive as those which had preceded them. It was at Bonn that he sent to the press the first part of his famous treatise on physiological optics, which was not completed until 1895, and there also that he carried out many of the researches on musical sounds which were embodied in his treatise on "Sensations of Tone." At Bonn, too, he published his first mathematical paper "On the Movement of Fluids" (1858), which led on to his experimental researches at Heidelberg in 1860. During the whole period it appears that he published some forty-six papers of importance, of which thirty-seven, including those on optics and acoustics, were on physiological subjects, the remainder being physico-mathematical.

After his appointment to the chair of physics at Berlin, his only physiological publication was the essay entitled "Thought in Medicine," in which he illustrated in the most striking way the application of the scientific method to pathological questions. (The chapters of Koenigsberger's work which relate to Helmholtz as a mathematician will be treated by abler hands. Many readers who may not have leisure to look into this admirable biography would have been glad had it been possible to give some account of Helmholtz's views as to the limits of a scientific inquiry and the relation between the experimental sciences and philosophy. Want of space forbids this.)

In Koenigsberger's book the reader will find ample material for the decision of the question which presented itself at the outset, that of the conditions which led to the development of so splendid a character. To the present writer it seems evident that Helmholtz's personal qualities—his sagacity, modesty, truthfulness, and astonishing power of work—could be in great measure attributed to home and school influences, and that his success as an investigator was due in part to his having entered on his career as a physiologist at a time when the progress of the exact sciences had rendered their methods applicable to the investigation of vital phenomena, and in part to his singular good fortune in having as his fellow-students such men as du Bois-Reymond, Ludwig, and Brücke, each of whom was as enthusiastic as himself, and scarcely inferior to him in intellectual endowments.

J. BURDON-SANDERSON.

II.

PHYSICO-MATHEMATICAL RESEARCHES.

Herr Koenigsberger gives us an account of Helmholtz which is extremely interesting, and not unworthy of the investigator of whom he writes. Though he paints for us a fascinating picture of Helmholtz as a man, it is with work as a great physiologist and physicist that he chiefly deals.

A review of that part of the biography which deals with the education and physiological work of Helmholtz precedes this notice, which is confined to a brief account of that part of the book treating of his physico-mathematical writings. Helmholtz's first mathematical paper was "On the Integrals of Hydrodynamical Equations which correspond to Vortex Movements," and was published in 1858, during his short stay in Bonn as professor of anatomy and physiology. In the following year, after his migration to Heidelberg as professor of physiology, appeared his paper "On the Motion of Air in Pipes with Open Ends." These two papers contain some of his most brilliant mathematical deductions, and are characterised by their freedom from the artificial or inaccurate assumptions of his predecessors. Further work in this direction was for the time prevented by family troubles. In June, 1859, his father died of a sudden stroke, and Helmholtz, worn out with sorrow at his loss, with anxiety for his wife, and with his own bad health, was obliged to turn to work requiring less concentration of thought. At the end of the year his wife died. For some time his health remained in an unsatisfactory state, and he was subject to headache and fainting fits. However, he forced himself to work, "which alone could give him power to hold out," and continued his hydrodynamical investigations, publishing in April, 1860, his paper "On the Friction of Viscous Fluids." His experimental researches on sound then led him to study the mathematical theory of violin strings and reed organ pipes.

Continuing his researches in acoustics and optics, he was led by the consideration of the wave motion near the end of an open cylindrical tube to investigate the distribution of electricity near the circular intersection of two surfaces. However, in this, the first of his many papers on mathematical electricity, he had been anticipated by Thomson. He then for some years confined himself mainly to physiological work, and it was not until 1868 that he was again led by his

acoustical researches to the study of hydrodynamics. Shortly after this his physiological work induced him to again attack electrical problems. From the study of electrical oscillations he proceeded to a discussion of the most general form of expression for the potential of single "Stromelemente," and of the differential equations which determine the motion of electricity. In this first treatise on electrodynamics, Helmholtz aimed at giving a clear summary of all results previously obtained.

In 1871 Helmholtz was appointed to the professorship of physics at Berlin in succession to Magnus, which post he held until 1888. From this time onward he confined himself almost entirely to physics, and did very little more physiological work. In the following year, after the marriage of his daughter Käthe, and a visit to Scotland (where he met Tait, Andrews, Huxley, Brown, Sylvester, &c., and found golf less easy to master than science), he published further papers "On the Theories of Electrodynamics." In these he replied effectively to the criticisms of Bertrand, Weber, &c., and, basing his researches on Neumann's potential law, he investigated the various theories that had been put forward, showing that Faraday's assumption of dielectric polarity was the only theory consistent with observed properties of open and closed circuits. For a short time after this he applied his versatile genius to the problem of artificial flight and guidable balloons, made valuable contributions to the theory of the microscope and anomalous dispersion, and turned his attention to the origin of thunderstorms. He then returned for some years to his researches in electricity, and applied Faraday's theories to electrochemistry, producing papers on electric currents in fluids and "elektrische Grenzschichten."

In 1878 commenced his lifelong friendship with Hertz, whose investigations led Helmholtz back to his electrodynamical researches, and to the discussion of the electromagnetic theory of light. In 1881 he again visited England, where he delivered his famous "Faraday lecture" (one of the best lectures he ever gave), which was received with the greatest enthusiasm. The delivery of this discourse led him to further investigations in electrochemistry, and in "The Thermodynamics of Chemical Processes," published in 1883, he discusses the relations of chemical combination, heat, and electrical potential, distinguishing between the "free" energy of a system which can be entirely converted into work and the "bound" energy which cannot be so converted. After journeys to Rome and England, he undertook a masterly development of the principle of least action, a principle which he considered as probably being the controlling law of all reversible processes of nature.

During the last year of his professorship at Berlin Helmholtz returned to his work on electrical and thermodynamical chemistry, and to the development of the "principle of the decrease of free energy in chemical processes." In 1888 he was appointed president of the newly-founded Physico-technical Institute, a position in which he had comparative freedom from routine work, and so was enabled still more thoroughly to devote himself to those investigations for which he was so peculiarly fitted. His first great work in his new position was the adaptation of the equations of hydrodynamics to the case of layers of gases of varying density, and the application of his results to meteorological phenomena. The remaining four years of his life were devoted to more work on the mathematical theory of electricity. The most important papers were those on the application of the principle of least action to Maxwell's electrodynamical equations, on the electromagnetic theory of colour dispersion, and on Maxwell's theory of the motion of the ether. He died, after two months' illness, in 1894.

HAROLD HILTON.

THE EARTH-HISTORY OF CENTRAL EUROPE.

Central Europe. By Prof. Joseph Partsch, Ph.D. Pp. xiv+358; with maps and diagrams. (London: William Heinemann, 1903.)

PROF. PARTSCH'S geography of Central Europe forms a volume of the series "Regions of the World," edited by Mr. H. J. Mackinder. Written in German, it has been well translated by Miss Clementina Black, and has also undergone a little condensation, probably to its advantage. On the east and part of the south, the region has fairly definite physical boundaries, in other directions they are more often political; but practically Central Europe includes the two great empires of Germany and Austro-Hungary, with Switzerland, Belgium and the Netherlands on the one hand, Montenegro, Servia, Bulgaria and Roumania on the other. But in the main there is a general correspondence between the political and the physical boundaries of the region, for Central Europe, geographically speaking, as Prof. Partsch remarks, is a three-fold belt of Alps, of inferior chains and of northern lowlands, and wherever one of these elements dies out Central Europe comes to an end. This is the best natural definition, though we should have preferred the term central highlands to "inferior chains," and a little clearer insistence on the fact that the great mountain chains of Europe—the Alps, Pyrenees and Carpathians—are comparatively modern physical upstarts, the highlands being much more ancient regions, which, like some old families, have come down in the world. Still, Prof. Partsch makes it clear, in a chapter which certainly would not stand any more compression, that the development of Central Europe was a long and complicated story. His remarks on traces in the Alps of valley systems older than the present, illustrated by some rough but sufficient diagrams after Prof. Heim, will be very suggestive to students, though full justice can hardly be done to the subject within the limits of this volume, because mountain making in this region was a complicated and intricate process, involving many speculative elements. He does well also in calling attention to the aggressive habit of some rivers; the more active one cutting back through the old water parting and capturing the other's tributaries. The Maloya Pass affords, of course, a typical example of

this process, but it has probably occurred on an even greater scale under the shadow of Monte Rosa, where the depths of the Upper Val Anzasca have replaced summits which once connected the former peak with the ranges about the head of the Saaser Visp.

But before Alps, Pyrenees, or Carpathians existed, Europe had its river systems, which, notwithstanding their revolutionary effects, may still be traced. For these we must look to the great zone of the central highlands, which, in earlier days, must have marked the watershed of Europe so far as it then existed. We can, indeed, infer this history from Dr. Partsch's chapters, but its geographical outlines might well have been drawn with a firmer pencil. But his sketches of the different regions of Europe are clear and graphic, not forgetting the scenery and structure of the great Alpine chain, among which we may mention that of the Karsh region of the south-east, with its singular system of underground drainage, outliers of which may be found here and there farther west, notably in the Steinerne Meer, near the König See, and sometimes even in the Western Oberland. The chapters on the North German lowland and adjacent seas, on climate, ethnology, and economic geography are particularly good, and the value of the last is increased by small maps showing the chief productive areas of cereals, potatoes, vines, and other useful plants, as well as of minerals. The growth and relations also of the States into which Central Europe is now divided are briefly sketched, and the professor, in remarks upon the zeal lately shown by Switzerland in fortifying the heart of the Alps, takes some little pains to assure this State that the Teutonic Codlin, not the Gallic Short, is the friend. Who lives, will see.

We think Prof. Partsch makes "block" mountains and fractures a little too prominent, and object to his use of the term rift valley, though aware that he can quote precedents. If the Upper Rhine is a rift valley, we are unable to see how it differs from a "fault valley," *i.e.* one the general line of which has been determined by a fault or set of faults. Rift valley, in the most proper sense of that epithet, belongs to an extinct phase of geology, when the Alpine lakes were located in gaping fractures; it becomes almost absurd, as Prof. Partsch's own diagram shows, when applied to the above-named region or to the valley of the Jordan, but there are now geologists who take much pleasure, first in coining a dubiously appropriate term and then misapplying it with a lavish hand. One or two other dubious matters may as well be mentioned. It would be more correct to say that the crystalline rocks of the Mont Blanc *massif*, on their underground course towards the Bernese Oberland, plunge under the Alps of Vaud than of Fribourg; it is misleading to speak of schistose rocks being associated with the *nagelfluh*, and it would have been well to have spoken more dubiously about ancient coral reefs as origins of the East Alpine Dolomites. These, however, are but details. The book displays a temperate avoidance of extreme views, is well printed and illustrated, is clearly and attractively written, and will be most useful to both teachers and learners.

T. G. B.

OUR BOOK SHELF.

A Treatise on the Theory of Solution, including the Phenomena of Electrolysis. By W. C. D. Whetham. Pp. x+488. (Cambridge: University Press, 1902.) Price 10s. net.

THE present work is a rewritten and greatly expanded version of the author's book on "Solution and Electrolysis," published in 1895. It embraces practically all the material on the subject of solutions which is dealt with in the ordinary text-books of physical chemistry, except that part concerned with velocity of reaction and purely chemical equilibrium. The treatment throughout is characterised by great clearness, especially in the physical and mathematical portions, so that the volume may be warmly recommended to students of chemistry who desire to increase their knowledge of this department of the subject. The first chapter is on the general principles of thermodynamics, so far as they are necessary for subsequent developments, and is followed by chapters on the phase-rule and on solubility. Then comes the discussion of the phenomena of osmotic pressure, and the related magnitudes of the lowering of vapour pressure and of the freezing point, to be succeeded by a judicious chapter on the theory of solutions in which the hypotheses of molecular bombardment and of chemical combination are weighed and compared. Thereafter come four chapters on electrolytic conductivity and electromotive force, leading to an exposition of the theory of electrolytic dissociation. Two useful chapters on diffusion in solution, and on solutions of colloids, conclude the work.

A valuable appendix consists in the tables of electrochemical data compiled by the Rev. T. C. Fitzpatrick, and reprinted from the British Association Report of 1893. This extends to nearly 80 pages, and gives the conductivity, migration, and fluidity data which had at that time been determined for aqueous solutions. The book is also provided with an excellent index, which adds to its value as a work of reference.

The Study of Mental Science. By Prof. J. Brough. Pp. 129. (London: Longmans, Green, and Co., 1903.) Price 2s. net.

THIS very readable little book is a collection of five lectures in which Prof. Brough has urged with force and eloquence the claims of logic and psychology to take their place in every curriculum designed to give a liberal education. He claims that the study of logic develops and brings clearly before the consciousness of the student the "natural sense of method" which in the scientific specialist too often works in devious subterranean fashion. Logic, treated as a study of scientific method, should be taught at that stage in the educational course at which a general survey of knowledge has been made, and before the student enters upon one of the more specialised courses of study prescribed by the honours schools of our universities. This sound principle, practically interpreted, means that logic should be made an obligatory subject for all candidates in the matriculation examinations of the universities, that, for example, in the "Little-go" logic should replace "Paley," which for the intelligent student is merely a study in one branch of logic, the study of fallacies. For psychology our author does not attempt to claim so urgent and universal importance. It is rather as a complement to the "humanities" that he urges its claims. In the modern world "the panorama of spiritual presentation through which we move" grows overwhelmingly rich and varied, and the mind can hope to cope with it profitably only when its knowledge of spiritual fact is systematised by analysis of psychical processes and by clear conceptions of the elements so revealed and of the laws of their conjunction. Prof. Brough is known as an enthusiast

for the modern experimental treatment of psychology, and has the merit of having introduced these methods in the University of Wales; it is therefore regrettable that he has not dwelt upon the value of psychology, so treated, as a training in accurate observation. For no other experimental science exercises so constantly, or makes so exacting demands of, the faculty of close observation and the power of voluntary control of the attention, the development of which two powers is, or should be, a prime object of all educational efforts.

W. McD.

Photography. Edited by Paul N. Hasluck. Pp. 160. (London, Paris, New York, and Melbourne: Cassell and Co., Ltd., 1903.) Price 1s.

Hand Camera Photography. By Walter Kilbey. Pp. 124. (London: Dawbarn and Ward, Ltd., 1903.) Price 1s. net; cloth, 2s. net.

THESE little books are both intended for beginners in photography. The comprehensive title of the first is reflected in the claim made in the preface that the "Handbook contains, in a form convenient for every-day use, a comprehensive digest of the knowledge of photography, scattered over more than twenty thousand columns of *Work.*" Doubtless the volume will be of value to readers of *Work* in saving many a reference to its thousands of columns, and as it is written chiefly by a professional photographer, others will probably be interested in such chapters as that on retouching. Much of the matter is too concise. It is impossible, for example, to give useful directions for the making of a 20 × 15 wet collodion negative in less than one small page, including instructions as to what to buy for the purpose.

The second volume is of a different kind. It is written by an amateur for amateurs, and the author has proved by his published photographs that his experiences are valuable. Of course, everyone will not corroborate all the opinions expressed, for the book has individuality and does not pretend to be a comprehensive treatise. It is essentially popular in style, and meets several difficulties that trouble beginners, and that many authors do not think of referring to. But Mr. Kilbey has surely forgotten himself when he suggests the use of a swing back in order to get such a view as an abbey with a foreground of rushes more easily into focus. Some ten pages further on an example of distortion due to tilting the camera is illustrated. We fear that some will infer from these illustrations that tilting the camera gives distortion, while swinging the plate does not. The book will be found to be a very useful guide by those who use hand cameras, and whose knowledge of photography is but slight, while others who may rank with the author in experience can hardly fail to find useful suggestions.

Mise en Valeur des Gîtes Minéraux. By F. Colomer. Pp. 184. (Paris: Gauthier-Villars, 1903.) Price 3 francs.

MOST of the French treatises on mining hitherto published deal chiefly with the extraction of coal, and this unpretentious and inexpensive volume will therefore undoubtedly prove useful to managers of metalliferous mines. It gives a clear summary of modern practice in metal mining. It is up-to-date and compact with facts. The matter is divided into ten chapters, dealing respectively with the definition of an ore-deposit, access to the deposit, method of working, breaking ground, rock-drills, explosives, transport, raising ore, drainage and ventilation. The work concludes with a brief glossary of technical terms. The absence of illustrations renders some of the descriptions somewhat obscure. The author has, however, carried out his task with care and accuracy, and has produced a volume valuable to the student desirous of becoming familiar with French mining terms.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Psychophysical Interaction.

MY authority for attributing to Descartes the distinction between "creation" and "direction" is Leibniz's "Theodicée" (Erd. 519). I ought to have stated more clearly than I did that he, of course, conceived of the problem in the form in which it presented itself to his age as one of "motion" rather than of energy and momentum. In referring to the history of the discussion at all, I merely meant to indicate its antiquity. This, of course, is no reason why it should not be reopened now. Every generation of thinkers has to adjust old solutions to new forms of a problem. It is, however, a reason why we should inquire whether a controversy of so long a standing may not be founded on a radical misunderstanding.

The object of my letter, if I may repeat it, was not to advocate the removal of the discussion from the field of fact to the *nirvana* of monistic idealism, as Sir Oliver Lodge suggests, but the preparation of the way for a better understanding between the combatants by inviting them, experimentally, at least, to consider the facts from a different point of view, or rather from the point of view of the most fundamental of all facts, our own will and personality. In making this suggestion, I expressly disavowed the introduction of anything transcendental that might dazzle the eyes or divert attention from the "landscape" or the "wayside." The suggestion, on the contrary, was that wayside facts might be better understood and unsatisfying controversy avoided, while, at the same time, the end which I understand Sir Oliver Lodge desires in the vindication of the reality of mind might be more legitimately achieved if we reminded ourselves at times that the road is a part of the landscape, and that both of them (to recall an old simile), both as they are and as they are known, are the work of the sun. So far from being put forward in the name of any one philosophy, this point of view, I maintained, is one which psychologists, pluralists and monists, realists and idealists alike, show a growing tendency to adopt.

The point at which the difference of attitude I advocate is most likely to come home to the physicist is that which Sir Oliver Lodge himself rightly emphasises in the donkey and carrots illustration. The psychologist only asks him to carry this far enough, following the facts as they take him from animal reaction to conscious volition and determination by ideas, on the chance that, when this point has been reached, a new view of the relation of the terms he has been accustomed to oppose to each other as matter and mind may be seen to be possible, and questions such as that raised by Mr. Culverwell in the letter following Sir Oliver's own in your issue of June 18 as to whether one state of motion in the molecules of the brain could in theory be deduced from the preceding state, of whatever interest to the physicist, to be irrelevant to the more ultimate question of the reality and efficiency of mind. If the conception of a physical world as opposed to a mental can be shown (as psychologists are agreed it can) to be one which has grown up within the conscious subject as a mode of organising and utilising his experience, what reason can there be for representing matter as an independent reality reacting upon another which we call mind?

In conclusion, may I say that it seems to me one of the misfortunes of present day specialism that physicists and psychologists, like mind and matter themselves, on the common view (though unfortunately without their pre-established harmony), move in different spheres, writing in different journals, and exchanging words, if at all, from a distance? I am grateful to NATURE for its hospitality on the present occasion, and to Sir Oliver for his note of welcome. May I express the hope that he will return the visit and continue the discussion in the pages of *Mind*? I think I may promise him an equally hearty welcome, and if I am right as to present-day tendencies in psychological science, a congenial atmosphere. J. H. MUIRHEAD.

Birmingham, June 21.

Tables of Four-figure Logarithms.

FOR many scientific computations it is sufficiently accurate to work to four figures, but there have been complaints that the usual tables of four-figure logarithms are not accurate in the fourth figure. Thus, log 1·019 is given as 0·0080, whereas it ought to be 0·0082. The errors are met with only in numbers from 1000 to 2000. In consequence of this, some such tables are accompanied by a table specially intended for numbers between 1000 and 2000. Many physicists and chemists refuse to use four-figure tables for this reason, and advocate the use of five-figure tables, in spite of their greater size and the waste of time.

I beg to point out that Mr. J. Harrison has got over the difficulty in a very simple manner in the four-figure table published by him recently in his book, "Practical Plane and Solid Geometry." Even he, however, cannot avoid a possible error of 1 in the last figure. The first ten rows of differences have been replaced by twenty. The rest of the table is unaltered. I give a specimen of an old row of figures and how it is replaced. The cause of inaccuracy in the old system is apparent at once.

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
							This is replaced by												
11	0414	0453	0492	0531	0569						4	8	12	15	19	23	27	31	35
						0607	0645	0682	0719	0755	4	7	11	15	19	22	26	30	33

It is to be hoped that all four-figure logarithm tables will in future be printed in this way. The Board of Education is now printing tables of this kind for use in evening science classes.

JOHN PERRY.

Ship's Magnetism.

IN a review of my book on the subject of the "Deviations of the Compass in Iron Ships" which appeared in NATURE of June 18 and in the last paragraph, there are statements to which I would take exception. In this paragraph the reviewer finds "food for reflection" in that, after defining C.G.S. units in the introduction of my book, I stick to inches and to other units in the text and charts.

In view of the fact that every measurement in a ship is recorded in feet and inches, whether by constructors, engineers, gunners, or navigators, to have introduced the centimetre as a common unit of measurement in the text and tables would have been a serious drawback to the utility of the book.

Again, the values on the charts of horizontal and vertical force are given in terms which have been found most convenient in the several computations, whilst not detracting from their value as exponents of the changes of terrestrial magnetism which a ship may encounter during a voyage.

Whilst introducing the student to the modern C.G.S. units, the use of the British units is too recent for neglecting to mention them, hence their retention on the map at p. 16, accompanied by the necessary multiplier for converting them to C.G.S. units if required.

A table of errata has been published for some weeks, and sent to all known recipients of the book.

June 20. E. W. CREAK.

Mercury Bubbles.

RECENTLY during the course of an experiment I had occasion to boil water in presence of mercury. After ebullition had been going on for some time, I noticed that occasionally steam forming below the surface of the mercury carried with it a pellicle of mercury as it rose through the water in the form of a bubble. When it reached the surface of the water the pellicle usually burst, and the mercury fell back as a drop. By adjusting the intensity of ebullition, it was possible to bring the two liquids into such a state that, comparatively frequently—say ten times per minute—steam bubbles covered with mercury rose through the water and floated on its surface, and, hovering there for an instant, they cooled and contracted, and sank slowly down through the water. When the bubbles are formed in rapid succession, the phenomenon is one of great beauty, as their surfaces are extremely brilliant, being formed of mercury freshly drawn out before rising into the water. The mercury used in this experiment was the ordinary commercial article, and not freshly distilled. Grease had, however, been removed from it by boiling with a solution of caustic potash. Tap water was used.

I have since found that these mercury bubbles are easily produced in a variety of ways. The most striking form of the experiment is perhaps as follows:—About 30c.c. of mercury are poured into an evaporating dish and covered by a depth of about 1·7cm. of water. Bubbles are now formed in the mercury by forcing air under its surface through a bent glass tube drawn to a fine nozzle. When the bubbles reach a certain size they become pyriform and draw out from the surface of the mercury, and, rising through the water, float on its surface. The bubbles so formed have considerable stability, and usually last for 15–30 seconds before bursting. One having a diameter of about 1·9cm. was timed to have lasted for 75·6 seconds, floating on the water. When the break does occur, it has explosive violence, and drops of mercury are thrown through a considerable distance. The bubbles which reach the surface of the water intact do not vary, as a rule, much in size, the maximum diameter observed being 2·0cm. and the minimum 1·8cm. The weight of mercury in the bubbles may be determined by floating them into a watch glass, and weighing the mercury which falls down from them on bursting. There is always more than 0·150 gram in the pellicle, and rarely more than 0·200 gram. The mean of ten weighings gave 0·177 gram as the weight of mercury in these bubbles. From these data it appears that the mean thickness of the mercurial pellicle is 0·001cm. At the thinnest part, however, it must be much thinner, for, as the profile view shows, each bubble carries a drop of varying dimensions hanging from its lower pole. The bubbles float immersed nearly to their equator. In the majority of cases they remain covered with a skin of water, so that the meniscus of the water is not depressed round the floating bubble, but is raised round it. The skin of water may be made to retreat from the upper pole, or to aggregate itself into droplets on the surface of the bubble, without causing the rupture of the bubble, by the addition of a small amount of spirit to the water. The complete absence of the water skin from the mercury pellicle may be demonstrated by the dulling of the surface of the latter when breathed upon.

The high surface tension of the water does not seem necessary to the phenomenon. Mercury bubbles in every way similar to those just described may be formed under methylated spirit, and will float upon its surface; also the addition of a slight contamination to the water, such as oil or soap or spirit, does not make the mercury film of the bubble completely unstable. But when large quantities of these impurities are added, the bubbles seldom last more than a moment on the surface of the water, although even in the presence of these impurities they may last as long as 25 seconds.

The depth of the overlying water is of importance in the ease of producing stable bubbles by this method. If it is deeper than 2cm. the bubbles usually break before getting to the surface; this is probably due to the change of pressure during the rise of the bubble through the water, and consequent excessive expansion causing rupture. If the water is less than 1·5cm. deep the bubble formed swells up to a great size (2–3cm. in diameter) before it,

leaves the mercurial surface, and generally bursts in doing so.

Considerable impurities in the mercury do not render the production of these bubbles impossible. Very stable bubbles may be formed of mercury contaminated with sodium. But the most stable have been formed from mercury recently cleaned with dilute nitric acid followed by a solution of caustic potash.

Another striking and beautiful experiment with the production of these bubbles may be made by directing a strong jet of water into a shallow vessel containing some mercury. The stream of water, carrying air bubbles with it, penetrates the supernatant water and impinges on the mercury below. There it forms numerous bubbles of various sizes contained in mercury pellicles, many of which detach themselves from the mercury below, and are carried about in the water. The stability of these bubbles is amazing. They are often whirled round and round in the turbulent motion of the water for several seconds without bursting.

HENRY H. DIXON.

Botanical Laboratory, Trinity College, Dublin.

Radium Fluorescence.

IF a tube containing radium bromide is wrapped in black paper and brought within three or four inches of the eye, in a dark room, a curious sensation of general illumination of the eye is experienced; this occurs whether the eyelid is closed or not. It is difficult accurately to describe the sensation produced; the eye seems filled with light. This effect can readily be detected when six florins are placed between the closed eye and the sample of radium.

Probably the effect is due to general fluorescence of every part of the eye, for fluorescence seems to be a commoner property of matter than hitherto suspected.

The following substances are distinctly fluorescent under radium radiation:—

Opal Glass.	Quartz.	Human Skin.
Soda Glass.	Sulphur.	Human Nails.
Lead Glass.	Sugar.	Camphor.
Uranium Glass.	Starch.	Cetaceum.
Didymium Glass.	Fluor Spar.	Solid Paraffin.
Celluloid.	Yellow Resin.	Liquid Paraffin.
Mother of Pearl.	Cotton Wool.	Turpentine.
Mica.	White Paper.	Chloroform.
Borax.	Cupri Sulph.	Water.
Alum.	Quinine Sulph.	Glycerin.

I have been unable to detect decided fluorescence in the following substances, however, with a more powerful source of radiation, or a more sensitive receiver than the eye; possibly some of these might be placed in the first list:—

Potass Bichrom.	Selenium.
Ruby Glass (flashed).	Plaster of Paris.
Prepared Chalk.	Iodosulphate of Quinine.
Ebonite.	Woods (various).
Silk.	Camphor Monobromate.

In the case of translucent substances, the effects are best observed by looking through the substance, placing the tube of radium nearly in contact with the far side. If the experiments are carried on too near the eye, the direct fluorescence of the eye itself interferes with accurate observations.

Little cups made of thick tinfoil are very convenient for the examination of liquids; the open vessel is viewed from above, the radium being placed below the cup.

It is important to well prepare the eye by excluding every trace of light from the room for at least a quarter of an hour before the experiments are made.

F. HARRISON GLEW.

156 Clapham Road, S.W., June 1.

A New Series in the Magnesium Spectrum.

IN your issue of April 16 there is an abstract of a paper communicated by Prof. Fowler on the above subject to the Royal Society. He shows that his new series is of the same type as the special series for magnesium discovered by Rydberg, and represents it by a similar formula to that used by Rydberg. But in "The Cause of the Structure of Spectra" (*Phil. Mag.*, September, 1901) I have shown that the Rydberg series for magnesium can be represented by a formula which brings out the existence of harmonics in atomic vibrations. These can be demonstrated in the hydrogen spectrum also, but it seemed to be of interest to inquire whether the new series gives a further example of the existence of optical harmonics. It does, for the vibration numbers of its four lines can be given by the formula

$$n = 39730 - \frac{107250}{(2 \cdot 977 - 2 \cdot 021/s)^2}$$

where s has the values 4, 5, 6 and 7.

This may be written approximately as

$$n = 39730 - \frac{107250}{\{3 - 0 \cdot 023 - (2 + 0 \cdot 023)/s\}^2}$$

while Rydberg's special series is represented by

$$n = 39730 - \frac{107250}{(3 - 2 \cdot 343/s)^2}.$$

I have not thought it worth while to test whether the harmonic formula for the new series is as successful as Rydberg's in giving the wave-lengths accurately, as the evidence for the existence of optical harmonics is what I wish to draw attention to. In Rydberg's series s has all the integral values from 3 to 8. In the new series Prof. Fowler gives wave-lengths for which s has integral values from 4 to 7. We might expect the lines for $s=3$ and $s=8$ to be yet found. Their wave-lengths by the harmonic formula would be 5125·8 and 3956·3.

Melbourne, May 27. WILLIAM SUTHERLAND.

THE KITE COMPETITION OF THE AËRONAUTICAL SOCIETY.

THE kite competition for the silver medal of the Aëronautical Society of Great Britain took place on Thursday, June 25, on the Sussex Downs, at Findon, near Worthing, by permission of Lord Henry Thynne. The conditions specified that a weight of two pounds as representing the weight of recording meteorological instruments should be carried, and that the medal should be given for the highest flight attained by a single kite above 3000 feet. The altitude of the kites was to be determined by trigonometrical observations.

The locality proved to be admirably adapted for the competition under the conditions of weather prevailing at the time. A light wind from the south-west blew up the slope of the Downs in the morning, and increased to a steady breeze in the afternoon, backing somewhat to the southward as the day, which was beautifully fine, went on.

It was understood that observations of the altitude of the kites should be commenced after the lapse of an hour from the signal for starting. By 2.45 p.m. stations for the kite reels had been arranged, 200 yards apart, along the slope of the Downs, and two stations for the theodolites, 700 yards apart, were selected, from which the kite stations were visible, and which were likely to command an uninterrupted view of the kites during the flight. The responsible duty of carrying out the measurements with the theodolites and the auxiliary chaining was most kindly undertaken by Mr. J. E. Dallas and Mr. W. F. Mackenzie, of the Royal Indian Engineering College, Coopers Hill, and the success of the arrangements was due in no small degree to the assistance afforded by these gentlemen.

At 2.45 the signal was given to start, and at 3.45 observations of height commenced. The synchronism of the observations of any particular kite from the two stations was secured at first by a prearranged code of signals from one theodolite station to the other, and subsequently by telephone between the two stations. Eight kites were entered for the competition, but only six appeared on the ground, and only

four reached a height sufficient to require trigonometrical determination. These were a Hargrave kite, of rhomboidal cross section, with four bands of linen, by Mr. S. H. R. Salmon; a kite of special design, by Mr. S. F. Cody, having the appearance in the air of a very large bird; a similar kite by Mr. L. Cody, and a Burmese kite by Mr. Charles Brogden.

In the course of an hour, four sets of observations were obtained for each kite, and were subsequently computed by Mr. Mason, of King's College, London, in accordance with a systematic programme drawn up by Prof. C. Vernon Boys.

As the result of the calculations, it appears that the greatest height measured for Mr. Salmon's kite was 1250 feet, for Mr. L. Cody's 1476 feet, for Mr. Brogden's 1816 feet, and for Mr. S. F. Cody's 1407 feet, and, therefore, none reached the minimum height required for the award of the medal. This unfortunate result was probably due to the fact that the wind, which had gradually increased from a light air as the sunshine continued, was a surface wind, and fell off in strength at some little height above the surface. The average heights of the several kites from the four observations of each were 1189 feet, 1271 feet, 1554 feet, and 1326 feet respectively.

At 4.45 the signal was given to haul in the kites, and all but one were safely brought back. The wire of this one had become entangled in the trees, and the kite was still in the air when the majority of the visitors had left the ground. The winding gear was in each case hand gear.

The supervision of arrangements for the competition was entrusted to a jury consisting of Dr. W. N. Shaw, F.R.S. (chairman), Prof. C. V. Boys, F.R.S., Mr. E. P. Frost, J.P., D.L., Sir Hiram Maxim, Dr. Hugh Robert Mill, Mr. E. A. Reeves, and Mr. Eric Stuart Bruce, secretary of the Aëronautical Society.

The society and its energetic secretary are to be congratulated upon having carried out successfully a series of arrangements that were necessarily elaborate, and not free from difficulties of many kinds.

THE CELTIC GOLD ORNAMENTS.

THE decision in the Court of Chancery that the gold ornaments from the north of Ireland, and bought as long ago as 1897 by the British Museum, are treasure trove, and, therefore, are to be taken from the Museum and handed over to the King, will produce a curious effect on the mind of the intelligent foreigner. But when he is told that the action at law is due to the persistent claims of the irreconcilable Irish party, he will probably begin to understand the position, from analogous conditions in his own country. The whole affair is to be regretted, but it must in fairness be stated that the entire blame lies at the door of the Irish executive, and that but for their incomprehensible apathy in making no effort to secure the ornaments before the British Museum ever entered the field, there would have been no need for a costly lawsuit. There is, however, a wider application of this particular example, arising from the contention of the Irish archæologists that all antiquities found in Ireland must remain there. Foreign students coming to an institution like the British Museum will expect to find there, primarily, an adequate representation of the archæology of the British Islands—surely not an unreasonable expectation in the central museum of the Empire. But if the Irish contention is to prevail, Scotland will claim equal rights, and Wales also when it decides on a capital for the Principality, so that the earnest student, not generally a wealthy individual, will be compelled to seek out what he wants in widely separated cities. There are, of course, arguments in favour of such a course; but, as a practical matter, there are, in fact, ancient remains enough in these islands to admit of the central museum having a fair comparative series, without in any way damaging the local museum. A little mutual understanding is all that is wanted, and it is to be hoped that the parochial idea that seems to prevail in Dublin will not be thought worthy of Edinburgh. London, after all, is the capital of these islands, and, for one foreign or English student in Dublin or Edinburgh, there are fifty, or, may be, a hundred, who work in London. The greater the number of workers, the greater will be the benefit to science.

THE UNIVERSITY OF LONDON.

THE presentation of degrées at the University of London, which took place as we went to press last week, was noteworthy in several respects. Honorary degrees were conferred for the first time in the history of the university, the recipients being the Prince and Princess of Wales, Lord Kelvin and Lord Lister; and representatives of the many and various institutions and organisations which are connected with the university, or are promoting its development, were also assembled together for the first time.

In his report on the work of the university during the year 1902–03, the principal, Sir Arthur Rücker, gave a short description of the educational scheme of the reconstituted university, beginning with arrangements which are primarily intended to be of benefit to those who are not aiming at degrees, and proceeding through the various stages of a university course to post-graduate study and research.

The following are some of the points of general interest mentioned in the report:—

Relation of the University to Schools.—The matriculation examination of the University of London has for many years served some of the purposes of a school-leaving examination. Persons who had passed it were excused by various professional bodies from their own entrance examinations; and for this or other reasons the examination was taken by many candidates who did not intend to pursue a university career. On the other hand, the Senate has for long included the examination of schools among its duties, and of late it has been felt that the time has come for performing this work on more modern lines and on an extended scale. A scheme has therefore been approved by the Senate for the inspection of schools, and the university has been recognised by the Board of Education as an authority under the Board for that purpose. This inspection will include an inquiry into the aims of the school, a consideration of its curriculum and arrangements as adapted to those aims, an inspection of the school buildings and fittings, and of the teaching work of the staff as tested by an inspection of the classes at work.

Entrance to the University.—The first matriculation examination under the new scheme took place in September last. It is a real matriculation examination in the sense that no candidate can begin his university career until he has passed it. It represents the minimum standard of admission to the university, and is intended to be such that it can be passed without special preparation or cramming by a well-educated boy or girl of about seventeen years of age.

The Senate has agreed to waive the matriculation examination altogether in the case of graduates of a large number of approved universities, and of persons who have passed the Scotch leaving examination or hold the *Zeugniss der Reife* from a Gymnasium or Real-Gymnasium within either the German or the Austrian Empire. A large number of persons have availed themselves of this privilege, which will be particularly valuable to those who may intend to supplement a degree taken at another university by study in London.

Courses of Study for Internal Students.—The distinction between an internal and an external student is that, while the latter can obtain a degree on passing certain prescribed examinations, the internal student must not only pass examinations but also produce certificates that he has attended courses of instruction approved by the university and controlled by recognised teachers.

The case of evening students has received special consideration. The hours of compulsory attendance are reduced in the case of those who submit certificates that they are engaged in some business occupation for twenty-five hours a week. The time required for the complete course varies with the subjects chosen, but in general the reduction allowed makes it possible for a student giving some three evenings a week to attendance on lectures and laboratories to complete a degree course in four years. It is satisfactory to be able to state that the regulations under this head are working smoothly at the polytechnics.

Organisation of Teaching.—It is not, however, only by curricula and arrangements as to examinations that the work of a teaching university must be carried on. It is also necessary to extend, organise, and coordinate the work of the teachers. This task requires funds, and also the cooperation of the various schools and other institutions connected with the university.

The Senate has approved a scheme for the establishment in the neighbourhood of the university of an institute of preliminary and intermediate medical studies, which has the support of the Faculty of Medicine, and has authorised the issue of an appeal for its building and endowment. When this is carried out, some, at all events, of the medical schools will be relieved of the necessity of maintaining independent courses of instruction on subjects which are only ancillary to medicine, and need not be studied in the immediate vicinity of a hospital. For the realisation of this project a large sum of money is required, but there can be no doubt that it will be an addition of the first importance to the equipment of London as a centre of medical study.

The attention of those interested in the teaching of engineering has been drawn to the proposals made by Mr. Yarrow in support of the system by which students of that subject spend alternate periods of six months in a college and the workshops. It is satisfactory to be able to state that in all probability some of the schools of the university will cooperate with employers in introducing into the metropolis a system of technical education which has worked well elsewhere.

Lastly, it may be added that the negotiations between the university and University College for the incorporation of the college in the university have been brought to a successful conclusion, and a joint committee has been appointed to draft a Bill for giving effect to the agreement. University College has purchased a plot of land in the neighbourhood of the hospital, to which the medical school will be transferred on an independent footing. This step is a necessary preliminary to incorporation, as it is not considered to be desirable that the university should itself control one, and one only, of the numerous medical schools which exist in London.

Post-graduate Work and Research.—The physiological department of the university, which is established in the university buildings, has been at work throughout the year under the direction of Dr. Waller, F.R.S., who has devoted the whole of his time to the interests of the laboratory. It will be remembered that all the principal teachers of physiology in London have banded themselves together to give, in turn, lectures to post-graduate students.

The research work carried on in the laboratory has resulted in the production of eight or ten original papers, which have appeared in English, American, and German periodicals.

The excellent example given by the physiologists has been followed by the botanists, who have in like manner agreed to give courses of post-graduate lectures at the Chelsea Physic Garden, a scheme which has only been made possible by the cordial cooperation of the trustees of the City Parochial Charities.

Gifts to the University.—The first year's payments on account of the grant of 10,000*l.* a year from the Technical Education Board of the County Council have been made, and the various professors and lecturers have been appointed and are now at work.

The Worshipful Company of Goldsmiths has presented to the university the very valuable library of pamphlets and other works relating to economics, collected by Prof. Foxwell, and recently purchased by the Company at a cost of 10,000*l.* To this munificent gift the Company has added considerable sums to aid the university in installing and maintaining the library.

During the year, Mr. G. W. Palmer, M.P., has contributed the sum of 1000*l.* towards the endowment of the physiological laboratory, and Mr. Alfred Palmer has made a contingent promise of a like amount for the same object.

In addition to their former munificent promise of 30,000*l.* in aid of the incorporation of University College in the university, the Worshipful Company of Drapers has presented 1000*l.* to the university, and a scheme is being drafted for the application of this grant to University College.

Apart from the grant of the Technical Education Board of the County Council, about 25,000*l.* has been given to the university by the above-mentioned donors in the course of last year.

Summary.—The foregoing report will, it is hoped, prove that the university is anxious to leave no part of its duties unfulfilled.

New avenues of work have been opened in connection with schools, with university extension, with the colleges, medical schools, and polytechnics; students are entering both for the ordinary matriculation examination and for post-graduate study and research in unexpected numbers. The authorities of the institutions connected with the university have in all cases shown the most anxious desire to work in harmony with it, and to arrange their classes to meet the conditions which the Senate has laid down.

But, while there are many grounds for hope, and while the university is doing its best to make itself worthy of public support, it must be frankly admitted that it can never adequately fulfil its duties without the supply of funds from public or private sources on a very large scale. The incorporation of University College cannot be carried out until another 100,000*l.* has been raised; the complete endowment of the Institute of Medical Sciences would need much more than that amount; the fuller organisation of teaching on lines which have been already adopted in the case of German, and towards which a small beginning has been made in the case of chemistry, would require very large sums. On the one hand, technical instruction is sorely in need of development; on the other, if funds were available, a scheme could be worked out by which students of literature and archæology might make full use of the magnificent libraries and collections which London possesses.

Lastly, the payment of the professors, which is in many cases very inadequate, and of the cost of their departments, depends so much upon fees and so little upon endowments that the expense of education in London is comparatively high. Those who are engaged in the work are convinced that the one thing needful is endowment adequate to make good the apathy of the past, and to secure the promise of the future. It is for London to say whence and when that endowment will be forthcoming, and to determine whether a university which is providing for all learners, from the evening student to the candidate who has already graduated elsewhere, shall control means and appliances worthy of the highest educational institution in the capital of the Empire.

After the Prince of Wales had been presented for the honorary degree of doctor of laws and the Princess for that of doctor of music, Prof. Tilden, Dean of the Faculty of Science, presented Lord Kelvin for the degree of doctor of science, and in doing so he said:—

My Lord the Chancellor, I present to you William Thomson, Baron Kelvin of Largs, for the degree of doctor of science, *honoris causa*. The illustrious son of a family famous for mathematical talent, for more than half a century Lord Kelvin filled the office of professor of natural philosophy in the ancient University of Glasgow. Two generations have passed since he entered on his professorship, and the advances in physical science which have distinguished the nineteenth century from all preceding epochs have been largely due to the influence of Lord Kelvin in promoting true ideas concerning the conservation of energy, the laws of thermodynamics, and their application to the

mechanics and physics of the universe. His untiring intellectual activity has led him also to inquire into problems interesting to the chemist and geologist, as well as those which are important to the physicist and engineer. He has calculated the probable size of atoms; he has studied the structure of crystals; he has estimated the age of the earth. But the world knows him best as the man who has shown how practically to measure electrical and magnetic quantities, and has made it possible to link together distant continents by the electric telegraph. It is he who has shown how to neutralise the effects of iron on the compasses of ships and how to predict the tides, and who has thus taught the mariner to steer safely over the surface of the ocean and to sound, as he goes, its depths and shallows. A greater philosopher than Democritus, in him are united the qualities of Archimedes and Aristotle. Regarded with affectionate reverence by his contemporaries, it cannot be doubted that his name will shine brightly through long future generations. In offering a place of honour to such a man the university confers lustre on itself.

Mr. Butlin, Dean of the Faculty of Medicine, then presented Lord Lister for the honorary degree of doctor of science in the following terms:—

My Lord the Chancellor, since the reconstitution of the university, the Faculty of Medicine has been almost continuously engaged in arduous and not always pleasant work, and to-night, as if in compensation, there falls to its lot—for I am but the mouthpiece of the faculty—the agreeable task of presenting my Lord Lister for one of the four first honorary degrees of the University of London. While every person in my profession is familiar with the work which he has done, and his name has become a household word in every part of the civilised world, comparatively few persons are acquainted with the obstacles which he has overcome. It is not only that, sitting down many years ago in front of a difficult problem of pathology, Lord Lister solved the mystery which had puzzled the brains of the greatest surgeons of all time, or that he then invented a means of meeting and overcoming surgical infection, but that he stood by his theory, and fought manfully for it, until at length, in spite of opposition, of envy, of lack of faith, and even of ridicule, he succeeded in carrying conviction to the minds of his own profession and of the world at large. And all this was done, and these things were borne, not for the sake of gain—care for which has never been a part of Lord Lister's character—but for the sake of science and for the relief of human suffering. It is well-nigh impossible for those among whom a great man lives to form a just estimate of the value of his work, whether in art or in science, but I venture to predict that the name of Lord Lister will be handed down from generation to generation, from century to century, until, more than 2000 years hence, he will be acknowledged by our descendants as the father of surgery, in like manner as Hippocrates is regarded by this present generation as the father of medicine. I, therefore, sir, beg to present the Right Hon. Lord Lister, and ask you to confer on him the honorary degree of doctor of science, and I do so with the happy confidence that the addition of his name will confer lustre now and in the future on the University of London.

The students who had gained degrees in various faculties of the university were then presented in groups by the Dean of each faculty.

A CHARLOTTENBURG INSTITUTE FOR LONDON.

THE magnificent proposals which Lord Rosebery laid before the County Council in his letter to its chairman, Lord Monkswell, on June 27 have roused feelings of keen interest and high hopes in many who, for years past, have been crying, as it seemed in the wilderness, to the nation, to the Government, to public bodies, and to private individuals to do something to improve our higher technical educational methods. Generally speaking, the cry has been ignored or else met with the reply that our fathers obtained the command of the sea, extended our commerce and made the country the greatest commercial centre of the world, so surely methods which were good enough for them are good enough for us. Passing strange, but were they content with the methods of *their* fathers? did the eighteenth century show no advancement upon the seventeenth century? At the beginning of the nineteenth century we were ahead of all nations in the use of gas as an illuminant; later on, our railway systems and our steamships became the envy of the world; other nations could not approach us in engineering. In the middle of the century we were pioneers in many chemical discoveries; but then, apparently, so much prosperity and success seems to have been too rich a diet, and we waxed fat and kicked.

Of late years the country has felt more and more the competition of other nations. The colour industry has forsaken our shores, the finest electrical machinery is made abroad, we go to America for labour-saving appliances. Thinking men have cast about and tried to find a reason why other nations should take our markets; but when it was first suggested that our deficiency in scientific and technical education was at the root of the matter, those who dared to make the suggestion were, if not mocked at, at any rate treated with scant courtesy.

Now, however, it is generally admitted that, unless we improve our educational methods, we shall fall behind in the modern race for advancement to such an extent that it will require almost a miracle for us to be able to pull up again.

Our secondary education is not what it should be, but it is gradually improving. Technical education, generally speaking, has been tinkered at. The polytechnics are doing good work, but they are largely engaged in turning out better workmen and foremen workmen, or taking the place of the old apprenticeship system. Lord Rosebery now comes forward, and, through the generosity of Messrs. Wernher, Beit, and Co. (who offer 100,000*l.*) and other large business houses, is able to offer to London the means for providing higher technical education. Briefly stated, the idea put forward is to supply London with a technical college after the lines of the world-renowned polytechnic at Charlottenburg, which represents the acme of technical education. It is not for teaching the elements of this or that science; but when the foundation of a thorough education has been laid, students can go there for the building up of the superstructure. It is not an easy matter for a student to gain entrance into the Charlottenburg Institute. A very thorough examination must first be passed, in order to show that he is capable to take advantage of the instruction offered.

The Charlottenburg Institute cost more than 500,000*l.* to build and equip, and entails an annual outlay of 55,000*l.* The offer made by Lord Rosebery to the County Council is one of 300,000*l.* to build the institute, and he has reason to think that the Commissioners of the 1851 Exhibition will grant the site (some four acres of ground). The County Council is asked to contribute 20,000*l.* a year for the maintenance of the institute. This sum may be sufficient at the commencement, but will probably be inadequate as the place becomes known and its value appreciated.

Is it right that the County Council should be asked to find the money? The institute is meant to be imperial. Londoners may and will attend it; but it is hoped by the donors of the funds that students from all parts of the British Empire will flock there, and thus make London, "at any rate, so far as advanced scientific technology is concerned, the

educational centre of the Empire." Lord Rosebery considers it "little short of a scandal that our own able and ambitious young men, eager to equip themselves with the most perfect technical training, should be compelled to resort to the universities of Germany or the United States." Why, then, should London, which is already overtaxed, and has much more yet to contribute to primary and secondary education, be called upon to pay for the upkeep of this great Imperial undertaking? Are our legislators so dead to the interests of the nation that they will refuse—if asked—to support such a scheme? or to find the much larger sum which will be required for the development of London University.

Lord Rosebery has agreed to act as the first chairman of the trustees. Presumably they will appoint a committee to advise and help them in drawing up and settling the scheme. It is to be hoped that they will use every endeavour to choose the right men, men who are thoroughly conversant with the needs of the nation, and who understand what technical education is.

The institute, if properly organised and equipped, will be a national gain, a national asset; if run on wrong lines a national loss. But with the magnificent institutes in Germany to adapt from, there is really no reason why it should not be a grand success. One thing, however, should not be forgotten, a splendid equipment without an equally good curriculum and organisation is almost valueless. It must also be remembered that the scheme does not touch the question of the provision for development required by the University of London.

The scheme outlined in Lord Rosebery's letter may, we hope, be taken as a sign that our great manufacturers are becoming aware of the national advantages to be derived from an alliance between science and industry. The meeting held at the Mansion House on Monday to inaugurate a memorial to the late Sir Henry Bessemer gave additional reason for the belief that an awakening is taking place. It was decided that a memorial should be established which should not only commemorate Bessemer's work, but also provide a means of carrying it on to further achievements. The proposals of the memorial committee, which were read at the meeting on Monday, include the provision of well-equipped mining and metallurgical laboratories, and scholarships for post-graduate study in London. In the words of the committee:—

> The establishment of completely equipped metallurgical teaching and research works in London will form the first object of the memorial, for which the practical cooperation and financial aid of the industrial world is asked. The primary aim will be the thorough technical instruction of mining and metallurgical students. Metallurgical tests and research of all kinds, for which facilities are not available in Birmingham or Sheffield, will be carried out at these works, on a practical scale, by engineers and others. In this way advanced students will be afforded opportunities for the acquirement of practical knowledge and for original research which it would be difficult to obtain in any other way. The second object of the memorial will be a system of grants, in the form of scholarships, for post-graduate courses in specialised practical work in London and the great metallurgical centres.

In proposing the adoption of this form of memorial, Mr. Haldane said the work which was to be done in teaching by the Bessemer Foundation should form a part—an integral part—of the larger scheme for raising the nation's efficiency. He had reason to know that the King was fully cognisant of the details of the great scheme which was laid before the public in Lord Rosebery's letter, and that His Majesty had also been informed of the proposal to launch the Bessemer memorial scheme in connection with and as an integral part of it.

The committee's proposals were adopted, and there is little doubt that the support which will be given to them will enable provision to be made for study and research in mining and metallurgy on a scale appropriate to Bessemer's great name, and to our responsibilities as a State. To maintain a leading position among the nations of the world, industrial methods must be developed in directions indicated by scientific research, and the recognition of this fact in the scheme for the proposed Charlottenburg Institute for London, and in that of the Bessemer Memorial Committee, will give satisfaction to all who are familiar with the developments due to the application of science to industry.

THE BRITISH ACADEMY.

THE first anniversary meeting of the British Academy was held last week. We have received no report, but we learn from the *Times* that the objects of the Academy, and the studies to be fostered by it, were described in the presidential address. In the course of this address, Lord Reay remarked:—

> The Academy might be regarded as embodying the recognition on the part of England that she, too, at last recognised that history, philosophy, philology, and kindred studies call for the exercise of scientific acumen, and must take their place by the side of the sister sciences, the priestesses of nature's mysteries.

We are all anxious to extend the boundaries of knowledge by scientific study, and Lord Reay appears to have overlooked the fact that the Royal Society was founded for the purpose of promoting the progress of the subjects he mentions, among others. The first charter granted to the Royal Society in 1662 contains the following words:—

> We have long and fully resolved with Ourself to extend not only the boundaries of the Empire, but also the very arts and sciences. Therefore we look with favour upon all forms of learning, but with particular Grace we encourage philosophical studies, especially those which by actual experiments attempt either to shape out a new philosophy or to perfect the old.

The recognition of the value of the application of scientific principles to all inquiries is therefore as old as Charles II., and has not recently been discovered as Lord Reay seems to suggest.

Lord Reay remarked that it would be one of the first important duties of the Academy with the Royal Society to prepare a fitting welcome for the International Association of Academies when it meets in London next year at Whitsuntide, and to make that meeting a success. The following points from the address show some of the directions in which the Academy is to work:—

> In history we have to deal with the mutual interaction of different civilisations, and to compare these civilisations. The task of the historian is very similar to that of the explorer of nature's laws. Our colleague, Prof. Bury, in his interesting inaugural lecture, has eloquently emphasised the application of strict scientific methods to the study of history, as the study of "all the manifestations of human activity." In the department of archæological exploration an understanding might be obtained through the International Association with regard to the spheres of scientific exploration which should be allotted to various nations, so as to arrive at a systematic distribution of archæological research in the vast domain open to the explorers of different nationalities. Many questions belonging

to economic science have to be studied. The scientific treatment of law has been neglected in England, and it will be our privilege to give encouragement to those who are striving to place the scientific study of law on a footing worthy of the great traditions of English jurisprudence. We shall approach the problems connected with education in a philosophical and historical spirit. Our charter imposes on us the duty of dealing with questions which embrace the whole range of the moral sciences. We have to deal with the problems of the mind. The complex agencies which constitute the motives of our actions are subjects of our investigation. The forces which influence individual energy are open to our analysis. To discover the principles which regulate the progress of human society, which eliminate the causes of friction, which facilitate the attainment of high ideals, all these inquiries come legitimately within the sphere of our operations. The unbiased attitude of the mind towards ethical and metaphysical problems is one of the conditions of our existence as a scientific body. The tendency of all scientific study is to become international and cosmopolitan. We may compare our Academy with a national clearing-house, and the International Association of Academies to an international clearing-house of ideas on these subjects.

NOTES.

THE names of a few men distinguished by their contributions to scientific knowledge are included in the list of birthday honours. Dr. W. D. Niven, F.R.S., has been promoted to the rank of Knight Commander of the Order of the Bath (K.C.B.). Dr. David Morris, F.R.S., and Dr. Patrick Manson, F.R.S., have been promoted to the rank of Knight Commanders of the Order of Saint Michael and Saint George (K.C.M.G.). The honour of knighthood has been conferred upon Dr. P. H. Watson. Mr. F. W. Rudler has been appointed a Companion of the Imperial Service Order.

THE Colombo correspondent of the *Times* reports that on a motion introduced in the Legislative Council on June 24, the Government of Ceylon agreed to invite the British Association to Colombo in 1907 or 1908.

DR. C. J. MARTIN, F.R.S., professor of physiology in the University of Melbourne, has been appointed director of the Jenner Institute of Preventive Medicine.

IN reply to a question asked in the House of Commons on Tuesday, it was announced that, in the first instance, the following six lightships are to be connected with shore stations by wireless telegraphy:—the East Goodwin, the South Goodwin, the Gull, the Tongue, the Sunk, and the Cross-Sand.

MANY friends of the late Sir William Roberts-Austen will be glad to know that it is proposed to erect a memorial in his honour in the Church of St. Martins, Blackheath, Wonersh, where he resided for many years. The erection of the church was mainly due to his generous and devoted efforts, and he often said that the first things done to complete the building should be to line the east wall and the chancel arch with marble or alabaster. It is proposed that the memorial should include the carrying out of this work, and the erection of a memorial tablet or inscription in the church. Contributions for this purpose should be sent to Mr. H. W. Prescott, Brantyngeshay, Chilworth, Guildford.

M. ZYBIKOFF, a Buddhistic Buriat of the Baikal region and a graduate of the University of St. Petersburg, has recently returned to Russia after a year's residence in the city of Lhassa. M. Zybikoff was able to travel in Tibet as a Lama, and approached Central Tibet by way of the Boumza Mountain, where Przewalsky was turned back in 1879. He describes the city as one of not more than ten thousand inhabitants; the Uitchu River passes to the south, canals and dykes protecting the city itself from floods. The residence of the Dalai Lama is on Mount Buddha La, a mile from Lhassa. Near it is the ancient castle of Hodson Buddha La, a structure 1400 feet long and nine storeys high, containing the treasury, the mint, quarters for officials and monks, and a prison. The native traders are all women.

MRS. GARRETT ANDERSON, M.D., in a letter to the *Times*, directs attention to the work of the Imperial Vaccination League, which has now been in existence a year. The League, which has on several occasions been referred to in these columns, was formed to study the administration and working of the "Vaccination Act," 1898, and to promote vaccination, and especially revaccination, among the public. It is now desired to extend its sphere of work by assisting candidates at Parliamentary elections to meet the pressure brought to bear upon them by the opponents of vaccination. For this purpose Mrs. Anderson appeals for subscriptions, and desires to find 100 friends who will each contribute five guineas a year for three years. The League has done good work in the past, and it is to be hoped that this useful extension will receive support.

ATTENTION was directed in the House of Commons last week to the administration of the "Cruelty to Animals ('Vivisection') Act," 1876. The debate was more moderate in tone than some previous ones on the same subject, and had for its main object the imposition of more stringent inspection by the appointment of additional inspectors. Sir M. Foster and Dr. Hutchinson strongly deprecated the attacks on, and abuse of, the medical profession with regard to this question, and obtained a retractation from Mr. MacNeill. The Home Secretary, in his reply, defended the inspections as carried out by Dr. Thane, and pointed out that successive Home Secretaries had been among the severest critics of vivisection, and that his own control was exercised with the greatest care and full appreciation of his responsibility. It would be almost impossible to improve upon the administration of the Act, and he doubted whether the ability of the inspectors was sufficiently recognised or remunerated.

REUTER reports that a violent earthquake occurred at Erlau, Hungary, on the morning of June 26. Four shocks were felt. Several houses in the suburb of the town collapsed, and nearly all the buildings in the town were damaged.

THE arrangements for the International Fire Prevention Congress, convened by the British Fire Prevention Committee, have now been completed. The congress will be conducted in general and sectional meetings; there will be six sections, each of which will have its own honorary chairman and acting vice-president. The sections with their honorary chairmen will be as follows:—(1) Building construction and equipment, Privy Councillor J. Stubben; (2) electrical safeguards and fire alarms, Chevalier Goldoni; (3) storage of oils and spontaneous combustion, M. Louis Bonnier; (4) fire survey and fire patrols, Prince Alexander Lvoff; (5) fire losses and fire insurance, Mr. C. A. Hexamer; (6) fire tests and standardisation, M. Alcide Chaussé. All meetings, except the opening meeting, will be held at the Caxton Hall, Westminster, and the whole of the executive arrangements will be in the hands of Mr. Edwin O.

Sachs, as congress chairman, with Mr. Ellis Marsland as honorary general secretary. The general opening meeting will be at the Empress Theatre, Earl's Court, lent by the executive of the International Fire Exhibition. The subject-matter is limited strictly to fire preventive questions, and all internal fire brigade questions will be excluded, as these will be dealt with at separate meetings.

A PARIS correspondent writes:—M. Santos Dumont's experiments in aërial navigation in Paris during the past fifteen days have attracted public attention. M. Santos Dumont was seen flying over the Longchamps Hippodrôme when a race was actually going on; at another time he went to his private residence in the Champs Elysées, left his balloon to the care of his assistants, who had followed his aërial track in an automobile, took his customary breakfast, and returned to the balloon shed near Puteaux Gate, in the Bois de Boulogne. On another occasion he sailed from the Puteaux Gate to Bagatelle, where he landed during a parade. But the area of his promenades is very limited, and sometimes the balloon has to be carried by hand for a part of the way; so it is not possible to say if M. Santos-Dumont has really improved his speed and stability.

THE fifty-sixth annual meeting of the Palæontographical Society was held at the Geological Society's apartments, Burlington House, on June 27. The report of the council referred to the activity of the contributors to the Society's monographs, which extended over a wider field than usual. Volumes on Pleistocene Mammalia, Carboniferous and Cretaceous fishes, Carboniferous and Cretaceous Mollusca, Trilobites, Graptolites, and Devonian corals were in course of publication. The expenditure for the year exceeded the income, which was nearly 100*l.* less than that of the preceding year. The withdrawal of several small libraries was referred to, and an appeal for new personal subscribers was made. The officers were re-elected, Dr. Henry Woodward as president, Mr. Etheridge as treasurer, and Dr. Smith Woodward as secretary.

TWELVE stations took part in the international scientific balloon ascents on the morning of May 7, including Zürich, for the first time, and Bath. The records for the latter station had not been found at the time of the publication of the preliminary results. The following are the most noteworthy of the unmanned ascents:—Strassburg, 13,400 metres; at 9500 metres the temperature was $-58^{\circ}\cdot3$ C., above this height an inversion of temperature occurred. The reading at starting was $10^{\circ}\cdot5$. At Berlin the balloon rose to 13,360 metres, temperature at 7560 metres was -43°, at starting $11^{\circ}\cdot9$. At Vienna a temperature of $-54^{\circ}\cdot4$ was recorded at 9020 metres, at starting $14^{\circ}\cdot8$. At the first two places the ascents were made about 4h. a.m., at Vienna about 7h. a.m. Relatively high pressure prevailed over south-east Europe, and a large area of low pressure to the northward, with its centre (29·5 inches) over the North Sea.

THE Meteorological Office pilot chart for July contains, in addition to the usual information, a most useful series of twelve maps exhibiting the direction of flow of the tidal streams round the British Isles at each hour from high water at Dover. They are reduced from the more detailed large Admiralty charts in three volumes of 36 sheets. To seamen the handy form in which the streams are now shown on the pilot chart will be invaluable, as the whole circulation is seen at a glance. Early in April last it is shown, by means of a small map, that there was a remarkable displacement of the Atlantic anticyclone, which was transferred northward beyond the 50th parallel. As a result, the Transatlantic liners, to and fro on the northern routes, experienced easterly winds right across the ocean, instead of the usual westerly and south-westerly winds. There were numerous reports of ice during May and the early part of June.

THE German Government has erected a new lighthouse on the island of Heligoland, which will supplant the old petroleum lamp that has long directed the commerce at the mouth of the Elbe. It is claimed for this light that it is one of the most powerful in operation. The distinguishing feature is the return that has been made to the old form of parabolic reflector, with a powerful illuminant in the focus, in place of the Fresnel lenses and prisms. The mirror in this case is of glass, 75cm. in diameter, and silvered at the back. An arc light with a current of 34 amperes is the illuminant. The positive pole of the carbon is so near the focus that it is estimated that the beam is not more than two degrees in diameter, and its candle-power is quoted as thirty millions. No protection against weather is provided in front of the light, and it is asserted that none is needed. Three similar mirrors and lamps are mounted in one plane round an axis, and the whole revolves four times in a minute, so that a flash is given every five seconds. A fourth mirror and lamp is provided in case of necessity, which will turn three times as rapidly, but it is not proposed to use this except in case of emergency. The duration of the flash is only one-tenth of a second. Herein the German firm of Schuckert and Co., the manufacturers, have followed the lead of the French authorities. It is, however, a question whether these brief durations have not been carried to an extreme. Undoubtedly one-tenth of a second is sufficient to make the maximum impression on the eye, when the light is brilliant. But with a hazy atmosphere, and the light much diminished, it is doubtful whether a longer duration should not be allowed. The experiment will be watched with great interest, both on account of the bold deviation from the ordinary plan which has been so long followed, and also on the ground of economy, which is claimed for the new method. It is stated that on the first night of trial the light was seen at the pier of Büsum, a distance of 64 kilometres, or 40 miles.

"THE Cure of Consumption," a popular account of the open-air treatment of pulmonary tuberculosis, and a description of "An Experiment in Nature-study," carried out among village lads, are two articles of scientific interest that appear in the current issue of the *Pall Mall Magazine*.

SEVERAL cases of fatal illness have occurred in connection with the Mond process for the extraction of nickel from its ores, which is based upon the conversion of the metal into gaseous nickel carbonyl. It is not yet known whether the nickel carbonyl is itself poisonous, or whether some other deleterious gas or substance is generated in the process, but the subject is being investigated by several experts.

THE statistics of the anti-rabic inoculations carried out at the Pasteur Institute, Paris, during 1902 have just been published. The number of persons treated was 1106, of whom three died, but one of these had not completed the treatment, leaving 1105 cases with two deaths, a mortality rate of only 0·18 per cent. This is the lowest mortality rate recorded since the commencement of the treatment in 1886.

THE new method for sewage disposal by bacterial treatment in a septic tank is not altogether free from danger. In this process the sewage is stored in closed tanks for a variable period, during which time it is acted upon and dissolved by the agency of the bacteria present. Probably

marsh gas and other gases are generated which become explosive when mixed with oxygen and fired. During the past six months three explosions of septic tanks have occurred, viz. at Exeter, Walton-on-Naze, and Sheringham; in the last named three persons were killed and several injured.

A PARLIAMENTARY paper has been issued by the Colonial Office containing official correspondence and circulars relating to the investigation of malaria and other tropical diseases, and the establishment of schools of tropical medicine. It contains a circular letter to the Governors of all colonies upon the investigation of tropical diseases and the establishment of the London School of Tropical Medicine, a summary of researches upon malaria by Drs. Stephens and Christophers, a despatch from Sir William MacGregor relating to the prevalence and prevention of malaria at Ismailia, and a despatch from Sir F. A. Swettenham upon the work done at the Institute for Medical Research, Federated Malay States. The increasing importance of the study of tropical medicine has been recognised by the Special Board of Medicine of Cambridge University, which has proposed to institute a special examination and to grant a diploma in tropical hygiène and medicine.

A PAPER read before the Royal Dublin Society by Dr. H. H. Dixon offers a reply to some criticisms passed on the cohesion theory of the ascent of sap which was proposed by the author and Dr. Joly. There seems to be a difficulty in the minds of some botanists in accepting this hypothesis if the column of water contains air-bubbles. As Dr. Dixon points out, this merely puts out of gear the particular cell in which the bubble appears. Another opinion which the author combats is that glass tubes containing plaster of Paris through which water passes may be taken as the equivalent of the water columns in trees. Experiments show that plaster continues for a long time to absorb water, and further, the amount varies with the changes of temperature.

THE appearance of a new scientific publication, *Records of the Albany Museum*, emanating from Grahamstown in South Africa is a matter for congratulation, whether it is offered to the director, Dr. Schönland, or in so far as it furnishes an indication of the sign of the times. Dr. R. Broom contributes three palæontological articles, in the first of which he describes the skull of a small lizard taken from the Triassic beds in South Africa. Dr. Schönland is responsible for the remainder of this, the first part. A critical account of a number of species of South African aloes adds considerably to the information collected by Mr. J. G. Baker in his monograph in the "Flora Capensis." In addition to the botanical papers, Dr. Schönland describes some Bushman and Hottentot pottery which is stored in the museum. A pot about 14½ inches high, consisting of a wide neck slightly ornamented by raised lines and a remarkably fine curved base, approximately oval, denotes workmanship of a higher order than that displayed by the civilised potter.

WE have received the second part of the *Sitzungsberichte* and *Abhandlungen* of the Dresden "Isis" for 1902. The former contains an obituary notice of the late Hofrath Dr. H. Nitsche, professor of zoology at the Academy of Tharandt. Among the contents of the latter is an article, by Prof. O. Schneider, on the prevalence of melanism among the beetles of Corsica.

AN interesting case of "commensalism" is recorded by Dr. R. Horst in the May issue of the Leyden Museum *Notes* (vol. xxiii. part ii.). In Sabang Bay, Poeloe Weh, several small fishes (*Amphiprion intermedius*) were observed to issue from the cavity of a large anemone of the genus Discosoma. Several previous instances of a similar association are on record, notably in Australian waters, where other species of Amphiprion have been observed frequenting anemones of the genus above mentioned.

OUR knowledge of the fishes of Africa is progressing by rapid strides, one of the latest contributions to the subject being a paper on a collection from Zanzibar, by Mr. H. W. Fowler, published in the *Proceedings* of the Philadelphia Academy, in the course of which two species are described as new. The same serial also contains a revision of the land and fresh-water molluscs of Western Arkansas and the adjacent States, by Mr. H. A. Pilsbry.

WE have received a copy of the address on "Modern Views on Matter: the Realisation of a Dream," delivered by Sir William Crookes before the recent Congress of Applied Chemistry at Berlin. A general account of the proceedings of the congress appeared in NATURE of June 18 (p. 156), and abstracts of some of the papers brought before the various sections are given in the present number.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. H. Padgett; two Two-spotted Paradoxures (*Nandinia binotata*) from West Africa, presented by Mr. Charles R. Palmer; a Burrowing Owl (*Speotyto cunicularia*) from South America, presented by Mr. L. M. Seth-Smith; a Diademed Sand Snake (*Lytorhynchus diadema*), five Egyptian Eryx (*Eryx jaculus*) from Egypt, two Bull Frogs (*Rana cotesbiana*) from North America, deposited; six American Flying Squirrels (*Sciuropterus volucella*) from North America, purchased; an Ogilby's Rat Kangaroo (*Bettongia penicillata*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

REPORTED CHANGE ON SATURN.—The following telegram, announcing the discovery of a new phenomenon on Saturn by Prof. Barnard, has been received from the Kiel Centralstelle:—

"Conspicuous white spot, Saturn, three seconds north, transit June 23, 15h. 47·8m., Williams Bay time.—Barnard."

SEARCH EPHEMERIS FOR FAYE'S COMET.—A search ephemeris for Faye's comet, from which the following is an extract, is published in No. 3876 of the *Astronomische Nachrichten* by Prof. E. Strömgren:—

Ephemeris 12h. (Berlin M.T.).

1903	α h. m. s.	δ ° ′	$\log r$	$\log \Delta$
July 2	4 59 44	+18 41·8	0·2240	0·4060
„ 6	5 11 28	+18 42·6		
„ 10	5 23 6	+18 40·2	0·2281	0·4044
„ 14	5 34 37	+18 34·7		
„ 18	5 46 0	+18 26·1	0·2330	0·4028
„ 22	5 57 14	+18 14·5		
„ 26	6 8 19	+18 0·0	0·2386	0·4012
„ 30	6 19 13	+17 42·8		

This ephemeris is calculated from the elements previously published, in the *Astronomische Nachrichten*, by the same worker, and takes June 3·64 (Berlin M.T.), 1903, as the time of perihelion passage. The comet will rise about two hours before sunrise towards the middle of the month.

OBSERVATIONS OF NOVA GEMINORUM.—Prof. Barnard publishes in No. 5, vol. xvii., of the *Astrophysical Journal*, the results of his observations of Nova Geminorum; most of these observations were made with the finders of the 40-inch and 12-inch refractors of the Yerkes Observatory.

During the first set of observations the Nova had a strong reddish colour, but this has since disappeared,

Observations made in order to determine whether the light of this Nova exhibited the change of focus observed in the light of Nova Persei gave at first, negative results, but careful observations made on April 27 indicated that the light of the Nova, when compared with that of an ordinary star, showed a difference of +0·08 inch (2·00mm.) in focus.

The crimson image observed on March 30 had disappeared on April 27, the out-of-focus image of the Nova then resembling that of an ordinary star. Cloudy weather at Yerkes from April 7–27 prevented Prof. Barnard from determining the exact date at which this change took place. The magnitude of the Nova is exhibiting the same periodical fluctuations as were observed in the case of Nova Persei.

THE RED SPOT ON JUPITER.—In No. 3875 of the *Astronomische Nachrichten*, Mr. Stanley J. Williams describes, and gives the detailed results of, his observations of the "great red spot" during the opposition of 1902.

Transit observations of the middle of the spot gave a rotational period of 9h. 55m. 39·55s., and of the "following" end of the spot 9h. 55m. 39·88s.; taking the weighted mean of these observations, Mr. Williams obtains, from 275 rotations, 9h. 55m. 39·66s. as the result. This shows a further considerable acceleration of the rotational period of the red spot, amounting to 1·26s., as compared with the result obtained during the opposition of 1901.

THE STUDY OF VERY FAINT SPECTRA.—In a dissertation published in No. 35 of the Lick Observatory *Bulletins*, Mr. Harold K. Palmer describes an arrangement whereby the Crossley reflector has been adapted to the study of very faint stellar and nebular spectra.

The work was first suggested, but not completed, by the late Prof. Keeler for the purpose of obtaining, amongst other spectra, the spectrum of the faint central star of the ring nebula in Lyra.

A modified form of Prof. Keeler's proposed spectroscope has now been adopted, and the results obtained with it are very satisfactory; its essential features are as follows:—A concave quartz lens intercepts the converging beam of light from the large mirror, and renders the rays parallel; these parallel rays are then refracted by a 50° quartz prism and are focused on to the photographic plate by a convex quartz lens placed between the prism and the plate. The two lenses and the prism each have an aperture of 25 mm. An arrangement attached to the prism cell allows the prism to be moved to one side, so that the spectroscope may be focused for the incident light by means of an eye-piece which carries a finely divided scale, and another eye-piece, placed at the side of the movable slipping plate, allows the "following" during exposure to be performed in the usual manner.

Spectrograms of such faint objects as the stellar nebula NGC 6807 (magnitude 13), the Novæ in Perseus (1901), Auriga and Cygnus (1876), and the Wolf-Rayet star No. 43 have been obtained with exposures varying from one to four hours, and show a fair amount of detail.

Three spectrograms of the ring nebula were obtained, two with thirty minutes' and one with two hours' exposure, but the only trace of the central star is a faint line which appears on all three plates, and, in the longer exposure, shows a faint dot in a position a little to the more refrangible side of the condensation λ 373 in the nebula ring. A detailed description of each of the spectra obtained is given in Mr. Palmer's paper.

INSTITUTION OF NAVAL ARCHITECTS.

THE Institution of Naval Architects held its summer meeting this year in Ireland, commencing Tuesday, June 23, when the opening meeting was held in Queen's College, Glasgow, the president of the Institution occupying the chair.

After the usual formal proceedings, in which the members were welcomed to the city by Sir Daniel Dixon, the Lord Mayor of Belfast, and the Rev. Dr. Hamilton, president of Queen's College, three papers were read. The first was by Mr. C. F. L. Giles, the engineer to the Belfast Harbour Commissioners, and gave a brief description of the harbour and its development. Mr. E. H. Tennyson D'Eyncourt followed with a paper "On Fast Coaling Ships for our Navy." The author proposed that certain vessels should be built specially to wait on the fleet and supply it with coal in time of war, and they should be fitted with appliances for transferring the fuel to the warships at sea. These vessels should be able to steam 17 knots easily and continuously, and 18 knots in case of emergency. They would have to be of considerable size, therefore, and would be loaded with 10,000 tons of coal, besides that needed for their own use. The author estimated that the requirements could be met on a length of 550 feet, a beam of 66 feet, and a draught of 27 feet with 10,000 tons of coal on board; that would enable the vessels to get through the Suez Canal. The horse-power necessary for 17 knots would be about 12,000. With quadruple engines the consumption of coal would be 1½lb. per I.H.P. per hour, so that at full speed the collier could go 1000 miles from the coaling station and back on 800 tons of coal, carrying 10,000 tons of coal for the use of the fleet. That would be sufficient to coal completely five of our largest battleships or cruisers, or, if needed, ten such battleships could have their bunkers half full.

Comparing this with the present conditions, it would take one of our large cruisers or ironclads four or five days to make the 2000 miles, and she would lose at least 1000 tons of coal, and have to be steaming hard all the time. The vessel would arrive with dirty boilers, a tired complement of stokers, and the greater part of her coal already burnt. In ordinary peace time the colliers could be used for taking coal to the coaling stations. The cost of these vessels, fully equipped, with Temperley transporters and all the necessaries for quick coaling, would be about 270,000*l*. each, so that four or five could be built for the cost of one first-class armour-clad or cruiser, whilst four could be kept in commission for about the cost of keeping up an armour-clad. In time of war, the author claimed, each collier would be equal to several additional warships, as it would enable so many of the latter to remain at sea, saving them the time of going to and fro for coal, and giving them an opportunity to clean their boilers and do minor repairs to the engines, besides resting the whole crew, officers and men. In the discussion which followed the reading of this paper, it was pointed out that it was more reasonable to transform a mercantile vessel into a collier in time of war than to build such vessels purposely for an occasion that might never arise.

Mr. James Hamilton, of Glasgow, next read a paper in which he described an ingenious means which he had devised for converting a moderate speed steamer into one of very high speed for war-like purposes. He pointed out that the extreme speed now demanded by the Admiralty for the new mercantile cruisers to which it was proposed to give subsidies was higher than could be used, with profit to the owners, during peace time for ordinary Transatlantic service. The Admiralty asked 25 knots; Mr. Hamilton put the limit for mercantile use at 22 knots. If engines are not worked up to the power for which they are designed, they are uneconomical in themselves, whilst for excessive speeds very great engine power is needed. In order to solve this difficulty, Mr. Hamilton proposes triple-screw steamers, with one central screw and two wing screws. For the 25-knot speed all three screws would be used, and their respective engines would therefore be at work at their full power, and so be operating economically; for the 22-knot speed the two wing screws only would be used, and in order to prevent the drag of the central, idle propeller, the latter is drawn forward, with its shaft, until the blades of the screw touch the stern-post of the ship. This stern-post is so formed that the blades lie snugly against it, and in this way the resistance of the water flowing past the idle propeller is got rid of. For a four-bladed screw the stern-post is made of cruciform shape by the addition of two horizontal wings. In the discussion on the paper, it was pointed out that the shape of the stern-post was not favourable to speed on account of the eddy-making resistance. Mr. Hamilton, in reply to the discussion, said, however, that the objection was not of so serious a nature as was supposed, supporting his contention by diagrams illustrating the stream-line theory.

On the second day of the meeting, Wednesday, June 24, Prof. J. H. Biles read a paper "On Cross-Channel Steamers," in the course of which he gave particulars of certain vessels, and discussed the different qualities needed

for success in this particular kind of craft. The paper was illustrated by a large number of drawings of various vessels.

A paper "On Registered Tonnages, and their Relation to Fiscal Charges and Design" was read by Mr. James Maxton. In this the author pointed out some of the absurdities and anomalies incidental to the present stage of the law in regard to the tonnage of ships. A long discussion followed, in the course of which many speakers gave expression to the opinion that a change in the law was absolutely necessary in the interests of shipowners, harbour authorities, and, also, passengers. Several shipowners who spoke laid it down as a principle that in cross-channel steamers every passenger should have a separate berth, and it was only the way in which tonnage was measured that prevented such a desirable feature being introduced.

Prof. W. H. Watkinson read a paper in which he described some new features of superheaters. He pointed out that, even with a separate condenser, and all the other improvements that have been made since the time of Watt, from 12 per cent. to 30 per cent. of the steam supplied to an engine is condensed during its admission to the cylinder. The steam turbine is the only engine in which this condensation of the steam by previously cooled surfaces does not take place, but the steam in turbines is wet from expansion while doing work. Liquefaction of steam may be reduced by steam jacketing; by compounding the cylinders; by steam separators; by a special arrangement for sweeping the condensed steam out of the cylinder at each stroke; by reduction of clearance surface; and by superheating. The last, the author said, was by far the most effective. During superheating, although the pressure of the steam remains constant, its volume is greatly increased. The amount of heat required to superheat 1lb. of steam by 150° F. is 72 British heat units; this is only about 6 per cent. of the heat required to generate 1lb. of dry saturated steam. The increase in volume due to this additional 6 per cent. of heat averages about 30 per cent. In some cases where superheated steam is used, the superheating is only carried so far as to reduce, or at most to annihilate, initial condensation. In these cases the steam, after it has been admitted to the cylinder of an engine, becomes ordinary saturated steam before or at cut-off, so that during expansion some condensation of steam takes place, due to work being done at the expense of the internal heat of the steam. There is, then, no advantage due to the increase of volume of the steam during superheating, but there is great saving in steam and in coal, due to the reduction of initial condensation and leakage of steam past the valves and pistons. In the case of large engines of the usual type, it is not possible to superheat the steam by more than 200° F., and in some cases there is trouble with the valves if the degree of superheat exceeds 150° F. With piston valves the limit can be considerably exceeded. The author next discussed the question of independently-fired superheaters, and those in which the apparatus is placed in the uptake of the boiler or is heated by gases from the furnace. A superheater to which a gas-producer was attached was also illustrated and described by the author.

In the discussion on this paper, Mr. A. F. Yarrow said that superheating was the direction in which engineers must look for improvement in the economy of the steam engine. The difficulty in lubricating the cylinders of steam engines had been spoken of, but it was well known amongst engineers that for years the torpedo boat builders had never used internal lubrication for the engines of the craft they built. It was interesting to note that water would ooze through places where steam would not pass, and for this reason piston valves might be worked with superheated steam without metal being in rubbing contact with metal. Mr. A. Morcom gave some particulars of a vertical engine in which superheated steam had been used. It was a 500kw. engine, and the steam was at 600° F. With saturated steam the consumption of water per kilowatt-hour was 21lb.; with superheated steam it was 16lb.

During the stay in Belfast, the shipyard and engine works of Messrs. Harland and Wolff, and those of Messrs. Workman and Clark, were visited. There was a steamer trip down Belfast Lough, a reception at the harbour offices, and a dinner given by the Right Hon. W. J. Pirrie at his residence at Ormiston.

On Thursday, June 25, members proceeded to Dublin, where they attended a garden party given by the Lord Lieutenant at the Vice-regal Lodge; rain entirely spoilt the pleasure of the reception. In the evening there was a ball at the Mansion House.

On the following day the members met in the lecture theatre of the Royal Dublin Society, when Mr. A. F. Yarrow, vice-president of the Institution, occupied the chair. A paper by the Hon. C. A. Parsons was first taken, the subject being "Modern Steam Turbines, and their Application to the Propulsion of Vessels." The paper was largely of an historical nature, and gave particulars of the various vessels in which the steam turbine had been fitted, such as the two unfortunate torpedo-boat destroyers, *Viper* and *Cobra*, which were both lost at sea. The *King Edward* and *Queen Alexandra* were two passenger steamers that had been running successfully on the Clyde. The *Queen* is a cross-channel steamer, built for the Dover-Calais route, and has been put on her station since the paper was read. She has machinery of 8000 I.H.P. On her trial on the Skelmorlie mile she made a mean speed of 21·73 knots. Another boat of the same type, to be fitted with turbine engines, has been built for the L.B. and S.C.R., and will be put on the Newhaven-Dieppe route. She is 280 feet long and of 34 feet beam, and will shortly be launched. Three large yachts have lately been fitted with steam turbines, the largest being the *Lorena*, built by Messrs. Ramage and Fergusson, of Leith. She is 253 feet in length and of 33 feet 3 inches beam. The steam turbines in this vessel are similar to those of the *King Edward* and *Queen Alexandra*, but somewhat larger. The trial of the *Lorena* took place in the Firth of Forth in May, the speed attained being 18 knots. The turbine yacht, the *Tarantula*, built for the late Colonel McCalmont by Messrs. Yarrow and Co., was of the torpedo-boat type, but with somewhat heavier scantlings. She made 25·36 knots on her trial trip, her displacement being 150 tons. The *Velox* is a torpedo-boat destroyer recently purchased by the British Admiralty. She has machinery similar to that which was in the *Viper*, and will be capable of developing upwards of 10,000 H.P. Two small triple-expansion reciprocating engines, each of 150 H.P., are fitted for cruising speeds up to 13 knots. The steam from these exhausts into the turbines, where its expansion is completed before it passes to the condensers. Another torpedo-boat destroyer, the *Eden*, will have machinery of 7000 H.P., and her speed will be 25½ knots; whilst a third-class cruiser, *Amethyst*, built for the British Government, will have turbines of 9800 I.H.P., her speed being 21¾ knots. The author looked forward to the time when steam turbines would be fitted to vessels of the largest size, such as Atlantic liners. The experience with the marine turbine up to 10,000 H.P. in ships of fast as well as of moderate speed had tended, he claimed, to justify the anticipation—guided by theory—that the larger the engines the more favourable would be the results as compared with the reciprocating engines. The saving in weight, space, attendance and power would be still more marked with turbine engines of above 10,000 H.P., and up to 60,000 H.P., for which designs had been prepared.

The remaining paper read at the meeting was on the Dublin Harbour works, the author being Mr. J. P. Griffith. During their stay in Dublin the visitors took a steamer trip down the Dublin Bay, and on the evening of Friday the Institution dinner brought the meeting to a close.

THE INTERNATIONAL CONGRESS FOR APPLIED CHEMISTRY.[1]

SO many papers on analytical methods were presented that it is impossible even to enumerate them. The International Commissions on Analysis and on the Analysis of Fodders and Manures had not received all the reports yet which the Paris meeting had called for; the two Commissions over which G. Lunge presided—Maercker (Halle), chairman of the second Commission, having died—held some of their meetings jointly with sections i. (analysis) and vii. (agricultural chemistry). The proposals for a uniform method of drawing up analytical reports were made by W. Fresenius (Wiesbaden); Ch. Guillaume (Sèvres) reported

[1] Continued from p. 158.

on the mass of the c.o. of water and on thermometer scales.

Section ii. received some important communications on the auto-purification of waters. G. Weigelt (Berlin) has experimented on the rates of diffusion of refuse waters into river courses when introduced in different circumstances; tests based upon average contamination are quite misleading when injury to the fish is concerned. River water can, owing to its contents in carbonates, bind enormous quantities of sulphuric acid and also of alkalis, by decomposition of the bicarbonates, and iron salts are quickly deposited. F. Fischer (Göttingen) spoke on technically pure water, and regretted that biological tests seemed to supplant chemical analysis; the methods of sample taking were faulty. In section viii. Vandevelde (Gand) remarked that rest, absence of antiseptic and chemical compounds, presence of living organisms, and aëration favoured the auto-purification of water courses. Hygiene and navigation were in opposition; in flat country districts rivers should be doubled, a canal to serve for navigation, and the old bed for purification. Ch. Dreyfuss spoke on the septic tanks of Manchester, Proskauer and Erlwein on the ozone-sterilisation plants of Siemens and Halske at Wiesbaden and Paderborn. On the suggestion of Klaudy (Vienna) it was resolved to bring the water question before the next congress.

G. Lunge reviewed the state of the sulphuric acid manufacture in a very able paper, recommending water-sprays (not vapour) for the lead chambers, and reaction plate towers with artificial draught, and pointing to the great improvements lately effected in concentration apparatus. Kestner (Lille) described his lead ventilators for artificial draught. E. Hart (Easton, Pa.) reported on sulphuric acid in the United States since 1900, and D. Pennock (Syracuse, N.Y.) on the progress in the soda industry in the United States. G. Beilby (Glasgow) reviewed the position of the cyanide industry, pointing out that the actual plants could supply more than twice as much cyanide as is wanted. Synthetic cyanide processes were further discussed, in different sections, by F. Rössler, G. Erlwein, and A. Frank. The latter two spoke particularly on the Caro-Frank process taken up by Siemens and Halske. The carbides of barium and calcium bind nitrogen when powdered and heated, forming $CaCN_2$, which, on extraction with water, yields $(CN.NH_2)_2$, and on fusion with salt (soda was used for the barium compound which was first prepared) sodium cyanide. The calcium cyanamide can also directly be prepared in the electric furnace from lime, coal, and atmospheric nitrogen. Decomposed with water vapour under pressure ammonia results; the calcium cyanamide also gives off ammonia in the soil, and is used as manure under the name of Kalkstickstoff. J. Bueb (Dessau) explained the recovery of the cyanogen from illuminating gas.

F. Mylius (Reichsanstalt) showed that the loss of weight which glass undergoes when treated with water would afford a basis for the classification of chemical glasses; an electric conductivity test practically gives the necessary data. R. Dralle described glass blowing machines; Heinecke, recent improvements in keramics effected at the Royal Porcelain Manufactory of Berlin; Vogt (Sèvres) and Heintze (Meissen) also contributed communications on their porcelains. H. Heraeus, of Hanau, showed his new resistance furnaces, in which platinum foil 0.007mm. in thickness is used instead of wire. The new iridium furnace, also shown, is an iridium tube 0.3mm. in thickness, which was directly heated by continuous currents up to 2000° C. With the aid of these furnaces and the experienced glass-blowers of Siebert and Kühn, of Cassel, quartz vessels are now made in Hanau. Ordinary quartz crucibles cost about half as much as platinum crucibles; they are attacked by metallic oxides and are permeable to hydrogen above 1300° C. (1100° C. according to Hahn), but do not crack on sudden cooling; water gas converts the quartz into tridymite. Siebert and Kühn had quartz thermometers on view. W. Hempel (Dresden) constructs simple high temperature furnaces by cementing small carbon rods to a zig-zag surrounding the crucible; the shell is iron lined with kieselguhr and carbon. Using an arc furnace and placing the substance in the cup of a hollow carbon rod, he has determined the following melting points:—magnesia, 2250°; lime, 1900°; alumina, 2068°; magnesite, 2000°; porcelain (Berlin) softens at 1550°; Meissen porcelain at 1850°. In these experiments a rod rests loosely on the substance, and breaks a contact when sinking. The temperature is determined with a Holborn-Kurlbaum optical pyrometer, or a Bunsen photometer of Hempel's, in which the rays are several times reflected: for this reason Hempel himself regards all these preliminary values as probably too low. H. Bunte (Karlsruhe) demonstrated with the aid of laboratory mantles that neither pure thoria nor pure ceria yield the high luminescence which we obtain by mixtures, and that very small percentages of uranium, platinum, &c., in thoria also produce brilliant lamps, but that none of these are durable. The luminosity is probably simply physical, but there may be catalysis.

Section iii*a*., metallurgy, discussed papers by H. Wedding and Th. Fischer on metallic hydrides, by C. Schiffner (Freiberg) and A. Lodin (Paris) on pyritic smelting, by Ch. E. Munroe (Washington) on mining, metallurgy, and explosives in the United States, Gin (Paris), on extraction of copper pyrites with SO_2, &c. In section iii*b*. Brunswig, Bichel, Blochmann, Mettegang, Eschweiler, Watteyne, O. Guttmann (London), Knight (Krümel), Lenze, Bergmann and others had long discussions on the Trauzl lead block test, determination of explosive velocities, transport of compressed gases and liquids, protection of explosive works against lightning, danger from perchlorates in powder, &c. O. Guttmann's proposal for an international committee on explosion tests in experimental mine galleries did not find sufficient support.

Section iv*a*. had many good papers by C. Engler, Bergner (Baku), Aisinmann (Campina), E. O'Neill (California), Harperath (Argentina) on petroleum; Charitchkow (Grossny) proposed to fractionate technically naphtha in the cold by means of alcohol mixtures. Connstein (Berlin) described the successful splitting-up of fats by the enzymes contained in Rhicinus seeds, &c.; Lewkowitch (London) referred to the same subject. Other papers were on cyanogen, illuminating and water gas (Bunte and F Fischer), saccharin (Fahlberg), &c.

Sections iv*b*., dyes; v., sugar; vi., fermentation and starch; vii., agricultural chemistry; viii., hygiene, pharmaceutical and medicinal chemistry, and foods; xi., legal and economical questions, were all very busy.

Section ix., photochemistry, discussed papers by J. M. Eder (Vienna) and Ollendorf (Berlin) on sensitometers; on latent images, by J. Waterhouse (Eltham) and Schaum (Marburg); on colour photography by additive synthesis, by A. Miethe and R. Neuhaus (Berlin); on photochemistry in the United States, the centrifugal bromide of silver, and other points, by L. Baekeland, Yonkers, N.Y.; on the resolution of the finest spectrum lines on Doppler's principle, by O. Lummer; and an exhaustive study of the dichroic fog, by A. Seyewitz (Lyon).

In section x., electrochemistry and physical chemistry, J. Traube and G. Teichner (Berlin) performed an experiment apparently disproving Andrews's views on the critical state of gases. A glass tube is partly filled with carbon tetrachloride; it contains also little spherical floats of glass of different densities. The tube is jacketed with paraffin and diphenylamine. When heated to and above the critical point, the meniscus disappears, and the floats do not all collect in the middle portion of the tube. This is to prove that there is no uniform density in the vapour. Repeating experiments of de Heen and Dwelshauvers-Dery, Traube considers that van der Waals's molecular gas volume constant b is not constant, but increases when the liquid passes into the gaseous state, and that the vapour contains liquidogenous and gasogenous molecules the proportions of which depend upon the temperature. At the critical temperature both molecules are soluble in one another in any proportions.

W. Nernst (Göttingen) showed an apparatus with the aid of which he has determined the vapour densities of CO_2 with 0.3017mg., of NaCl with 0.16mg., of S with 0.57mg. of substance. The substance is brought in an iridium vessel, which is lowered into a tubular iridium furnace of Heraeus and heated up to 1950° C. The weighing is done on a balance, consisting of a capillary glass tube as beam, bent down at the end to serve as pointer, and resting on a quartz thread; this balance weighs to 0.001mg., and can be loaded with 2mg. maximum. The values found

are, *e.g.* H_2O 17·1 (instead of 18), CO_2 42·9 (44), S 36 and 37·7 (32), so that the sulphur would appear to be monatomic at that high temperature.

E. Wedekind (Tübingen) produces colloid zirconium by reducing the oxide with magnesium and extracting with hydrochloric acid; O. Burns (Boston) colloids of paper, oxides, sulphides, &c., by shaking them for many hours. Monti (Turin) spoke on the concentration of solutions, perfumes, wines, and ordinary salts by freezing; the acids and salts collect in the microscopical interstices between the small ice crystals, and when frozen blocks are left to themselves, the substances diffuse downward; concentration by cold is more economical than by heat. Bredig (Heidelberg) and Count Schwerin (Höchst) spoke on electric osmosis, E. Solvay (Brussels) on a gravitation formula applicable to diffusion phenomena, Zengelis (Athens) on the production of very high temperatures by burning aluminium in oxygen and other gases. The kinetics of the catalytic sulphuric acid process were discussed by Knietsch (who has worked the process out in Ludwigshafen) in section ii., and by Bodenstein and Bodländer in x. Similar papers were read by Schenck (Marburg) on the splitting of CO, by H. Goldschmidt (Christiania) on the kinetics of reductions, by Bodländer on technical catalysis. H. Goldschmidt (Essen) reported on the manufacture of steel in the electric furnaces of Stassano, Gin-Leleux, Héroult, Keller, Kjellin, and others; Bancroft and A. A. Noyes on electrochemical research in the United States; Fr. Foerster (Dresden) and Brandeis (Aussig) on electrolytic preparation of inorganic compounds; M. Le Blanc (Karlsruhe) spoke on electrolysis with alternating currents and the possibility of determining the velocity of ionic reactions; Coehn (Göttingen) on electrode influence in electrolytic oxidations and reductions, H. Moissan on metallic carbides, Héroult on the efficiency of electrolytic soda processes, Danneel and Nissenson on the electrolytic deposition of metals, Küster (Clausthal) on dissociation pressure of soda solutions, W. Marckwald on his radio-active tellurium, and Precht (Hanover) on the spectrum and atomic weight of radium (in ix.). W. von Bolton demonstrated what he briefly calls luminosity of the ions. When a carbon rod is lowered as anode into sulphuric acid, containing a copper spiral as kathode, the rough surface of the carbon becomes at once bright under the influence of currents of 110 volts. When rods of metals (or of carbon) are dipped into solutions of their salts, the rod being the kathode, a platinum spiral the anode, the rod begins to glow in brilliant colours, and beautiful band spectra of the ions (?) are obtained, differing from the spark spectra which result when the anode is glowing. The discussions were very good.

H. BORNS.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES.

THE eighth annual congress of the South-Eastern Union of Scientific Societies was held at Dover on June 11–13. A lively address by the president, Sir Henry Howorth, F.R.S., put pin pricks into all the infallibilities, begging the student to accept no predominant hypothesis without demur, to resist the fascination of great names, to challenge the exactness even of the exact sciences. Fallacies might often lurk in phrases, as when "the survival of the fittest" was glibly used to mean nothing more than the survival of the survivors. The address impressed its hearers with the advantage which every branch of science might derive from the touch of a keen and active critical faculty, working outside the ranks of the specialists.

The papers contributed to the congress fall into three classes, the purely local, the general, and those of divided interest. In the last of these Mr. A. T. Walmisley's essay discussed the methods by which a traveller between Kent and the Pas de Calais might cross the intervening strip of shallow water, on, in, under, or over it, without the incidents which now so often befall him when the "silver streak" is converted into a tumultuous concourse of atoms. The new turbine steamer was indicated as the best chance for humanity—at least until something better is invented. Mr. W. Whitaker, F.R.S., observed that clearly nature had expressly designed the Straits of Dover for a submarine tunnel, though politicians might think otherwise. Mr. A. O. Walker, dealing with the effects of climate on distribution, compared his long experience of the fauna and flora of Cheshire and North Wales with his later observations while residing near Maidstone.

Of local papers the most important was that by Mr. Sydney Webb and Captain McDakin on the disappearing fauna and flora of the district. There were many lamentable and in part unavoidable losses. The dwindling of the colony of seals at Beachy Head was deplored, but no tears were seen to fall at the news that vipers were becoming scarce and polecats scarcer. The congress museum was instructively adorned by Mr. Webb's fine collection of Lepidoptera with their caterpillars, and by the display of plants with their seedlings from the Catford Society.

Prof. Boulger opened a discussion on the best means of checking the extermination of British plants and animals. Dr. Rowe, in a paper on the importance of zonal distribution, alluded to the doctrine that the souls of good geologists go hereafter to their favourite "sections," and hoped he might be allowed to stake out his claim to a particular slice of Dover Chalk, from which he had already abstracted about 5000 fossils.

The non-local discourses included an interesting account by the Rev. R. A. Bullen of "a late Celtic cemetery at Harlyn Bay," and a valuable investigation by Miss Ethel Sargent, who unfolded the story of Geophilous plants, explaining how these "lovers of the soil," to suit seasons and climates, for periods of varying duration, keep themselves close within the protecting bosom of their mother earth, the seeds and bulbs in the meantime, with a kind of vegetable instinct, ever using their foodstore to the best advantage. The concluding address was by Dr. Jonathan Hutchinson, F.R.S., the retiring president, who at two successive congresses has delighted his audience by a finely-argued discussion of a subject not at the first blush very attractive. His theme was leprosy. His theory is now well known, that this disease is caused by the consumption of badly cured fish, or occasionally by the eating of food which has been handled by lepers. During the last two years he has visited Africa and India, everywhere seeking out lepers and leprous communities, especially in places where he had been told that a fish diet was out of the question. Everywhere he found that in that particular his informants had been misinformed. A quotation from Erasmus sent to Dr. Hutchinson by a classical friend represented the Pope himself as proposing to proscribe the use of salt fish on account of its supposed tendency to spread leprosy, though it is not salt fish in itself that lies under any evil imputation. Erasmus often makes ironical statements, but on the foul effects produced in his day by the consumption of putrid fish his dialogue "Ichthyophagia" speaks with no ambiguity.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speeches delivered by Prof. Love in presenting M. Poincaré and Prof. Story-Maskelyne for the honorary degree of D.Sc. at the Encænia on June 24:—

Nescio an maximus inter mathematicos qui nunc vivunt sit Henricus Poincaré: vir iure mirandus non solum quod novis viis quærendi usus novos fructus adeptus est, sed quod tot et tam diversa doctrinæ genera unus complecti potuit, cum commentariis innumerabilibus fere omnes geometrices et analyseos partes illustraret. Cum in hæc recondita doctrinæ arcana altius penetrasset, rite eum Regalis Societas ornavit numismate aureo in memoriam Professoris nostri Sylvester instituto quod ei primo datum est. Non solum subtilissimis illis quæstionibus quæ de mathematicæ veritatis natura inter philosophos oriuntur hunc auctorem plerique sequuntur, sed ingenii maximi viribus nisus de luce, de vi electrica, de difficillimo quoque doctrinæ genere præclarissime disseruit. In Astronomia certe ea de motu et de figura planetarum est commentatus ut omnibus de hac re quærentibus nova quadam et meliore via insistendum sit. Hunc talem virum in omni genere doctrinæ insignissimum, rerum naturam animo peragrantem, geometren, physicum, astronomum præstantissimum, Academia nostra inter suos doctores libentissime adscribit.

Septem et quadraginta abhinc annos Willelmo Buckland successit Mervin Herbertus Nevil Story-Maskelyne, Minera-

logiæ primo Prælector mox Professor factus, quem honorem, nulli antea apud nos concessum, novem et triginta annos nullo intervallo retinuit, nec nisi octo abhinc annos deposuit. Primus etiam eodem fere tempore minerarum in Musæo Britannico custos creatus trium et viginti annorum labore effecit ut maxima vis minerarum omnium, nusquam alias in omni orbe terræ invenienda, intra parietes Musæi Britannici congereretur. Quod ad scientiam exquisitiorem pertinet, natura lapidum de cælo iactorum investiganda summam laudem adeptus est: idem minerarum et crystallorum formas et species accuratissime descripsit. Sed magistri boni præcipua laus in discipulis constat, neque silendum arbitror multos ex iis, qui hodie in hac scientia principes et signiferi sunt, hoc auctore et Professore doctissimo usos esse. Idem rude iam donatus a Musæo Britannico ita recessit ut rei publicæ se daret et Crickladensium suffragiis ornatus in publico totius civitatis consilio indivisi imperii vindex et defensor acerrimus sederet. Addo quod Regalis Societatis Sodalis et Collegii Wadhamensis socius honoris causa creatus cum multis virorum doctorum societatibus et in Europa et in America litterarum commercio coniunctus est.

PROF. J. LARMOR, F.R.S., has had the honorary degree of doctor of science conferred upon him by the University of Dublin.

A COMMITTEE has been formed with the object of raising a memorial in honour of the late Mr. T. G. Rooper, who died on May 20. Mr. Rooper held the office of H.M. Inspector of Schools in the Isle of Wight, Southampton and the neighbourhood during the last seven years, and both in his district and elsewhere he promoted the development of rational teaching of geography, natural history and other science studies. Information concerning the proposed memorial will be gladly supplied by Profs. F. J. C. Hearnshaw and J. F. Hudson, Hartley University College, Southampton.

THE appeal for funds for extending and modernising the scientific departments of the University of Dublin, to which reference was made last week (p. 188), should receive liberal support not only from graduates of the university, but also from all who sympathise with the cause of higher education in Ireland. Each science department of the university is in need of funds for laboratories, instruments, and other means of study and research. The university has already made considerable outlay in order to increase the efficiency of the scientific departments, but the new demands created by modern developments are too many and extensive to be met by existing resources, and it is necessary to ask for additional endowments if the university is to maintain its high position among the educational forces of the British Isles. In making the appeal for funds, it is pointed out that the important position assumed by modern science as a subject of collegiate education, and the great expansion of the scientific professions, render it incumbent on the older universities to make a costly provision for the adequate teaching of the experimental sciences. Not only must the universities of to-day be able to extend to their students—whether professional or in arts—sound theoretical and practical instruction in the established principles of science, but if these corporations are to continue to fulfil their duties efficiently, they must, in addition, provide facilities for research available both to student and teacher. In short, the demands on the resources of universities are not only for the endowment of chairs of science and the salaries of assistants and demonstrators, but also for the provision, equipment, and maintenance of lecture-rooms for teaching, and laboratories for both class-work and research. Moreover, the provision for laboratory equipment must be adequate to meet the ever-fresh demands of scientific advance. In the past the University of Dublin has discharged her duties towards the newer studies in a manner which has, in many particulars, set example to wealthier bodies. But a time has arrived when expenses must be incurred beyond her existing resources, and the University of Dublin must either obtain external aid to build and equip laboratories and lecture-rooms for physical science, electrical and mechanical engineering, botany and zoology, or conduct under grave disadvantages the instruction of those students who require to include these subjects in their professional training, or in their courses in arts.

A REPORT drawn up by a committee appointed by the Board of Trinity College, to consider the present scientific requirements of the college, shows that a sum of at least 100,000*l.* is needed by the scientific schools of the university. The appeal from which this statement of position and needs of the university has been taken is signed by Lord Rosse (Chancellor of the university), Mr. D. H. Madden (Vice-Chancellor of the university), Prof. Geo. Salmon (Provost of Trinity College), Lord Ashbourne, Lord Lansdowne, Lord Pembroke, Lord Ardilaun, Lord Iveagh, Lord Rathmore, Mr. E. H. Carson, Mr. W. E. H. Lecky, and Mr. J. H. M. Campbell. To carry the recommendations of the committee into effect, a considerable expenditure (for which no provision can be made out of college funds) must be incurred, including a capital outlay (for building and fitting laboratories and the like purposes) of 34,000*l.*, in addition to an annual charge for increased salaries and other expenses, estimated at 2730*l.* per annum. Lord Iveagh has generously offered to provide the capital sum of 34,000*l.* so soon as a sufficient amount has been collected and invested to produce the annual outlay contemplated by the committee (viz. 2730*l.* per annum), and this offer will hold good for three years from May 1 next; or if a sufficient annual income is assured by investments for carrying out the recommendations of the committee for any one department, he is prepared to contribute the capital expenditure necessary for the equipment of that particular department. A very large sum has to be collected during the next three years, but Lord Iveagh's offer ought to inspire others to contribute as generously as they are able to the subscription list. The Chancellor of the university, Mr. Benjamin Williamson, and Prof. W. E. Thrift are acting as honorary treasurers of the science fund.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 14.—"On the Radiation of Helium and Mercury in a Magnetic Field." By Prof. Andrew **Gray,** F.R.S., and Walter **Stewart,** D.Sc., with Robert A. **Houstoun,** M.A., and D. B. **McQuistan,** M.A., Research Students in the University of Glasgow.

The experiments had for their object primarily to test for lines of different substances, the proportionality of the change $d\lambda$ of wave-length, for each of the components into which a single spectral line is resolved by the application of a magnetic field, to the field intensity H, and to deduce the corresponding values of the ratio e/m of charge to mass of the electron. The apparatus consisted of a set composed of a large electromagnet (built to Prof. Gray's specification), and an echelon spectroscope of twenty-six plates with auxiliary (by Hilger, London). The readings were obtained by means of a micrometer eye-piece fitted to the observing telescope. The first observations were made at right angles to the magnetic field on several of the helium lines, and on the green line of mercury. The results were used to calculate the values of $d\lambda/H\lambda^2$, and of e/m by the formula $e/m=2\pi v.d\lambda/H\lambda^2$, where v is the velocity of light, 3×10^{10} cm. per second. In every case the normal triplet was obtained, and the separation between the extreme components found to be proportional to H up to fields of 10,000 C.G.S.; at fields above this the light becomes so faint, in all the tubes with which the authors worked, that it is impossible to obtain readings. The following table shows the results:—

Substance.	Wave-length, 10^{-8} cm.	$d\lambda/H$.	$d\lambda/H\lambda^2$.	e/m.
Helium ...	5016 (green)	$1{\cdot}61\times10^{-5}$	$6{\cdot}41\times10^{-5}$	$12{\cdot}1\times10^6$
,,	5876 (yellow)	$2{\cdot}07\times10^{-5}$	$6{\cdot}00\times10^{-5}$	$11{\cdot}3\times10^6$
,,	6678 (red)	$2{\cdot}90\times10^{-5}$	$6{\cdot}49\times10^{-5}$	$12{\cdot}2\times10^6$
Mercury...	5461 (green)	$2{\cdot}12\times10^{-5}$	$7{\cdot}12\times10^{-5}$	$13{\cdot}4\times10^6$

At a field intensity of 13,000 C.G.S. the centre component of the normal triplet was doubled, while each of the outer components was itself tripled. The polarisation of the two triplets and of the central doublet was the same

as that of the lines from which they originated, namely, that of the lines of the normal triplet. At all fields up to 13,000 the faint companion to the yellow helium line D_3 was not tripled, but only doubled.

For the above lines observations were made also along the lines of force, one of the magnet cores being replaced by a core drilled from end to end with a hole about a centimetre in diameter. The following table gives the numbers obtained :—

Substance.	Wave-length, 10^{-8} cm.	$d\lambda/H$.	$d\lambda/H\lambda^2$.	e/m.
Helium .	5016	1.75×10^{-5}	6.95×10^{-5}	13.1×10^6
,,	5876	2.24×10^{-5}	6.50×10^{-5}	12.3×10^6
,,	6678	3.13×10^{-5}	7.01×10^{-5}	13.2×10^6
Mercury...	5461	1.88×10^{-5}	6.31×10^{-5}	12.0×10^6

With respect to the green mercury line of wave-length 5461 tenth-metres, the authors incidentally observed fully a year ago, as they found afterwards had also been done a little earlier by Zeeman, that the line appeared to have three faint companions on the violet side, and two (they seemed at times to see three) on the red side. The companions are visible only under special conditions of the discharge tube. The values of $d\lambda$ for the first three are -0.208, -0.096, -0.059, and for the other two $+0.032$, $+0.067$. Though those values do not in every case agree with those given by Perot and Fabry, it is possible that, on account of hitherto unexpected complexity of the line, both sets of observations are correct.

It ought to be noticed here that Runge and Paschen have obtained a resolution of the green mercury line into three triplets in the magnetic field. This observation is entirely confirmed as to the side triplets by those of the authors (which were made before Messrs. Runge and Paschen's paper came to hand), but they have not been able to verify Runge and Paschen's result for the middle group, which appears to the authors to be a doublet. But the instrument of Runge and Paschen was a large Rowland grating of 6.5 metres diameter of circle, and the spectrum was photographed, so that their observations were, no doubt, more certain than the authors'.

May 28.—"Note on the Effect of Extreme Cold on the Emanations of Radium." By Sir William **Crookes**, F.R.S., and Prof. James **Dewar**, F.R.S.

The first endeavour was to ascertain whether the scintillations produced by radium on a sensitive blende screen were affected by cold.

A small screen of blende with a morsel of radium salt close in front was sealed in a glass tube, and a lens was adjusted in front so that the scintillations could be seen. On dipping the whole into liquid air they grew fainter and soon stopped altogether. Some doubt was felt whether this might not have been caused (1) by the presence of liquid, (2) by the screen losing sensitiveness, or (3) by the radium ceasing to emit the heavy positive ions. To test this two tubes were made, in one of which the radium salt could be cooled without the screen, and in the other the screen could be cooled while the radium salt was at the ordinary temperature.

The results were as follows :—(1) Radium salt cooled by liquid air. Screen at ordinary temperature. Scintillations quite as vigorous as with radium at the ordinary temperature, the screen and radium being *in vacuo*. (2) Radium at the ordinary temperature and screen cooled in liquid air. As the screen cooled the scintillations became fainter and at last could not be seen. On allowing the temperature to rise the scintillations recommenced. (3) A screen with a speck of radium salt in front of it was sealed in a tube. The tube was sealed off when a few fine drops of water were still remaining in the tube. The scintillations were well seen in this saturated aqueous vapour. The lower end of the tube was dipped in liquid air, which instantly condensed the aqueous vapour and left a very good vacuum. On now examining the scintillations they were if anything brighter and more vigorous than at first. When liquid hydrogen cooling was used instead of liquid air, the action was equally marked, showing that the highest vacuum that can be obtained by the action of cold does not diminish the scintillations.

In order to test the activity of radium in rendering air electrically conductive some radium bromide was sealed up in a glass tube and heated to the highest temperature the glass would stand, during the production of as high a vacuum as the mercurial pump would give. The whole tube was then immersed in liquid hydrogen contained in a vacuum vessel. On bringing the radium in such a vessel into a room in which a charged electroscope was placed it began to leak when the tube of radium surrounded with liquid hydrogen was some three feet away, and was very rapid in its action when a foot away from the electrometer. On immersing the tube containing the liquid hydrogen with submerged radium in another large vessel of liquid air and bringing the combination near the electroscope, the action was the same.

Prof. Rutherford and Mr. Soddy have made the important discovery that a condensable emanation is diffused into gases from solutions of radium salts, which is capable of condensation from the gas mixture at the temperature of liquid air. As it was important to ascertain what was taking place in this respect with the anhydrous radium bromide when isolated in the highest vacuum, the following experiment was arranged :—A glass apparatus was constructed consisting of a ∩-shaped tube having a bulb at one end, and being drawn out to a capillary tube at the other. Above the bulb was a plug of hard-pressed purified asbestos. The radium salt was located at the bottom of the bulb, and the whole was most carefully heated, exhausted to the limit of the mercurial pump, and sealed off. In the dark no trace of phosphorescence could be seen in any part of the apparatus unless from the pieces of the radium bromide. The capillary tube was now immersed in liquid air in a large flask, so that distillation might proceed undisturbed for days. After twenty-four hours of this operation, on looking at the capillary tube while covered with the liquid air, a marked phosphorescence was recognisable owing to some condensed emanation. The luminosity became naturally more marked the longer the time the action was allowed to proceed, and it is the authors' intention to continue the experiments for a lengthened period of time, and then seal off the fine capillary part so that the condensed product may be thoroughly examined.

Entomological Society, June 3.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. G. C. **Champion** exhibited numerous specimens of *Coccinella distincta*, taken in the pine woods of Woking. They were found, as usual, running about the ground in company with *Formica rufa*, and were perhaps wanderers from some other locality. Mr. Donisthorpe said the species was still common at Weybridge in the nests of *Formica rufa*, and that he had observed it also at Bexhill, while Mr. Chitty noted its former occurrence in Blean Woods in great numbers.—Mr. H. St. J. **Donisthorpe** exhibited a very remarkable melanic form of *Halyzia 18-guttata*, L., black with white spots, the type, which was also exhibited, being light brown with white spots. The former was taken at Oxshott on May 22. He also exhibited *Stilicus fragilis*, Gr., a melanic form with a black thorax instead of red as in the type, taken at Shirley on May 15; and *Staphylinus fulvipes*, Scop., taken by himself at Bamber Forest on June 1, a new locality for this rare beetle.—Dr. T. A. **Chapman** exhibited two full-grown larvæ of *Thestor ballus*, sent by Mr. H. Powell, from Hyeres, and read a description of them in their various stages. He also exhibited a larva of *Heterogyna paradoxa*, full fed, reared from the egg at Reigate, and a cocoon of *Orgyia auro-limbata*, with parasite microgaster. The microgaster and the moth both came from the same larva, and the moth, though containing a few eggs, laid none. An imago and a parasite from the same larva have not infrequently been recorded, but there has been some doubt on the occurrence.—The **President** exhibited the dry form of *Precis actia* bred by Mr. Guy A. K. Marshall from an egg laid by a female of the wet form. The parent was captured by Mr. Marshall at Salisbury, Mashonaland (5000 feet), on February 14; the egg was laid on the following day. It hatched February 20, the larva pupated March 16, the perfect insect, a male, emerged March 28. The differences between these two forms are as astonishing as those between the two phases of *Precis antilope* bred, the dry from the wet, by Mr. Marshall last year. The president said this

was the third South African species of the genus Precis in which Mr. Marshall had produced incontrovertible evidence of the specific identity of forms widely separated in colours, patterns, shape, relation of upper- to under-side, &c., and even instinct, including the selection of a particular type of country. The president also showed a small series of ants, part of a much larger collection made by the late W. J. Burchell in Brazil between the years 1825 and 1830. Considering their great age, the specimens were wonderfully well preserved, and were accompanied by remarkably exact and detailed data, and, in many cases, interesting notes on habits, instincts, &c.—Mr. O. E. **Janson** communicated a paper on the genus Theodosia and other Eastern Goliathides, with descriptions of some new species.—Colonel C. **Swinhoe** communicated a paper on new genera and species of the family Lymantriidæ in the National Collection.—Mr. G. W. **Kirkaldy** communicated a memoir on the Rhynchota collected by Dr. Arthur Willey chiefly in Berara and Lifu.—Prof. E. B. **Poulton** gave an account of experiments in 1893, 1894, and 1896 on the colour relation between certain lepidopterous larvæ and their surroundings, and especially the effect of lichen-covered bark upon *Odontopera bidentata* and *Gastropacha quercifolia*.

Mineralogical Society, June 9.—Dr. Hugo Müller, president, in the chair.—Mr. H. F. **Collins** gave an account of a remarkable mass of wollastonite with associated minerals which occurs at Santa Fé, State of Chiapas, Mexico. This mass of nearly pure wollastonite covers an area of 400 yards by 160 yards, and reaches to a depth of more than 300 feet; it is surrounded on all sides by granite, felsite, and other igneous rocks, and is separated by a mile from the nearest limestone. Near the outskirts of the mass occur extremely large crystals of wollastonite, most of which have been partially or entirely converted into quartz or semi-opal. Here are also found masses of garnet and of workable copper ores containing gold and silver. The author exhibited and described specimens of wollastonite, bornite in wollastonite, bornite in calcedony, gold-bearing linnæite, idocrase rock, and a remarkable intergrowth of bornite and galena resembling graphic granite.—Prof. H. A. **Miers** described the results he has obtained from the observation of the growth of crystals by a new method. The method consists in tracing the changes of angle upon a crystal during its growth by measuring it at intervals by means of a specially devised inverted goniometer, without moving it from the solution in which it is growing. It was found that an octahedron of alum yielded invariably three images for each face, so that the crystal had really the form of a very flat triakis-octahedron. Similar observations on other crystals lead to the conclusion that the faces of a crystal are in general not faces with simple indices, but vicinal planes slightly inclined to them, which change their inclination during the growth of the crystal. By determinations of the refractive index of the solution by means of total reflection within the crystal, it was found that in each case the liquid in contact with the growing crystal is slightly supersaturated.

Mathematical Society, June 11.—Prof. H. Lamb, president, in the chair.—The president announced that, after the conclusion of the current volume, some changes would be made in the form of publication of the *Proceedings*, the chief being an increase in the size of page and type.—The following papers were communicated:—Major P. A. **MacMahon,** The application of quaternions to the algebra of invariants.—Mr. G. B. **Mathews,** Jacobi's construction for quadric surfaces.—Mr. H. W. **Richmond,** Automorphic functions in relation to the general theory of algebraic curves. The object of the paper is to extend to curves in space of three or more dimensions the methods which have been developed by Poincaré and Humbert for the parametric representation of plane curves by means of automorphic functions. Curves are classified by their genus (or deficiency), their order and the number of dimensions of the space in which they lie, and the properties of all the curves in a class can be inferred from those of particular members of the class. The genera 1, 2, 3, 4, 5 are discussed in detail.—Prof. L. E. **Dickson,** Addition to the paper on four known simple groups of order 25920.—Prof. A. C. **Dixon** made an informal communication On a method of introducing the logarithmic function by means of geometrical properties of conics.

EDINBURGH.

Royal Society, June 1.—Dr. Munro in the chair.—Mr. George **Muirhead,** commissioner for the Duke of Richmond and Gordon, read a paper on the effect of temperature on the taking of salmon by rod and fly on the River Spey at Gordon Castle. From a careful examination of the full statistics which had been kept for a number of years, and a discussion of them in the light of various possible meteorological and climatic causes, the conclusion come to was that the number of salmon caught on a day was determined, to a large extent, by the variation of temperature during that day, the greater the variation of temperature the smaller the catch.—Dr. W. **Peddie** read a paper on the theory of colour vision. The theories which give the best account of the facts of colour vision and colour blindness are the Young-Helmholtz theory and Hering's theory. Both are trichromatic theories, and, apart from physiological or anatomical questions, both can, by proper choice of fundamentals, be made to give a good account of the main facts. The facts of one-eyed colour blindness show that, on the Young-Helmholtz theory, colour blindness must be regarded as due to fusion of at least two fundamental sensations. But the curves of one sensation, determined by observations on different eyes, differ considerably among themselves. This indicates that a broader basis for the theory may be desirable. This may be sought for in a tetrachromatic theory. But any such theory must explain the possibility of trichromatic representation of all colours. The theory proposed assumes two pairs of complementary stimulations, say, R, G_1 and G_2, V. In this respect it has a resemblance to Hering's theory. But whereas, in Hering's theory, stimulation of one member of a complementary pair means no stimulation of the other member, in the proposed theory equal stimulations of two such members gives white. It is shown that four sets of equivalent trichromatic fundamentals must exist. Assuming Helmholtz's fundamentals as such a set, the four mathematically possible sets of tetrachromatic equivalents, of which only one can exist physically, are deduced; and it is found that one of these does suit the known facts of colour vision and colour blindness. Choosing this set, the other three trichromatic equivalent sets (Helmholtz's being the fourth) can be deduced. The perceptibility curves (ordinates being differences of wave-length just appreciable to the eye in the spectrum) found for one of these sets is compared with that given by Helmholtz's set. The comparison is found to be very satisfactory. The nature of the tetrachromatic set shows that colour blindness must be regarded as due to suppression of one complementary pair of sensations, while variations in normal eyes are due to partial suppression. In this way the sensation curves for different eyes may have greater fixity as regards form, depending on wave-length, than in the trichromatic set. This result is desirable if the sensation curves are to be regarded as really corresponding to physiological stimulation produced photochemically or photoelectrically. A simple theory of such stimulation is given and shown to lead to the required form of relation between the four fundamentals.

June 15.—The Hon. Lord M'Laren in the chair.—Dr. **Horne** and Dr. **Peach** read a paper on the Canonbie Coalfield: its geological structure, &c. Though of limited extent, this coalfield has aroused considerable interest owing to the important series of plants obtained from the beds and to the questions bearing on the correlation of the Carboniferous rocks of the Scottish border with those of the north of England and centre of Scotland. About twenty years ago it was assigned by the Geological Survey to the Calciferous Sandstone series. At that time, however, great difficulty was felt in correlating the subdivisions of the Carboniferous rocks as there developed with those in the midland valley of Scotland, owing to the marked variation in some of the groups from the normal Scottish types. The palæontological evidence then obtained was not in accord with these conclusions, for the plants seemed to show that the coalfield really belonged to the true Coal-measures. Last year the Canonbie area was reexamined by the Geological Survey and Mr. Kidston. Deep bores have been sunk in recent years by His Grace the Duke of Buccleuch, and these also have furnished important geological evidence. By means of horizontal sections it was shown that the

following order of succession prevailed in the Lower Carboniferous rocks of that region:—(1) at the base, the Whita Sandstone resting on the Birrenswark volcanic platform; (2) the cement stone group; (3) the Fell Sandstones; (4) the Glencartholm volcanic group with Scorpion Bed; (5) a group of marine limestones, sandstones, and shales, with coal seams on two horizons—a lower, the Lawston Linn and Muirburn coals (Scremerston position), and an upper, the Kilnholm coals (Lickar position). The Upper Carboniferous Rocks of that region, embracing the Canonbie Coalfield, have been referred by Mr. Kidston to the Lower, Middle, and Upper Coal-measures, in virtue of the evidence obtained from the plants. The bores sunk in recent years near Rowanburn prove that the Rowanburn coals (Lower Coal-measures) overlie the marine limestone group with the Kilnholm (Lickar) coals; and that, further, the Red Sandstones and shales referred by Mr. Kidston to the Upper Coal-measures pass downwards into a series of thin coals which may be the upper part of the Byreburn series. An important economic question arises as to the extension of this coalfield, for it appears that there is good ground for the belief that the sandstones and shales of the Upper Coal-measure age overlie the Middle and Lower Coal-measures. In conclusion, it was shown by means of vertical sections that the Carboniferous succession in Eskdale and Liddesdale resembles more closely that of Northumberland than that of central Scotland.—As an important supplement to the foregoing, Mr. Kidston communicated lists of the fossil plants of the Calciferous Sandstone series of Dunfermline, of the Carboniferous Limestone of Eskdale, of the Lower Coal-measures of Canonbie, of the Middle Coal-measures of Byreburn, and of the Upper Coal-measures of Jockie's Syke, Cumberland, which borders on Dumfriesshire. Tables showing the horizontal distribution of the species were given, and some new and interesting species described, among these a new species of Pinakodendron (*P. Macconochiei*) being the first record of the genus in Britain.—A paper by Prof. **Ewart** on the wild horse will be printed in full in these columns.

DUBLIN.

Royal Dublin Society, May 19.—Prof. W. F. Barrett, F.R.S., in the chair.—Prof. T. **Johnson** gave an illustrated account of a tylose which he had found in a tracheide in the xylem of the rhizome of a bracken fern (*Pteris aquilina*, L.). He suggested that the disturbance in the transpiration current resulting from cutting the bracken might produce tyloses in the underground stem.—Mr. Richard J. **Moss** read a paper on an Irish specimen of dopplerite. This interesting substance does not seem to have been previously recorded as occurring in the United Kingdom, though it would appear from a reference to a peculiar form of peat in a report issued by the Commission on Bogs in Ireland in 1811 that the substance named dopplerite by Haidinger in 1849 had previously been observed in Ireland. The dopplerite recently found in a peat bog in the county of Antrim was in the form of an elastic jelly, velvety-black in colour, and drying to a solid of jet-like appearance, with a bright conchoidal fracture. In chemical composition it differs little from the peat in which it was found. It is shown that mineral matter, chiefly iron oxide and lime, which constitutes 5 per cent. of the dry substance, may be removed by steeping the jelly in hydrochloric acid without altering the consistence or appearance of the substance. The original jelly is acid to litmus, and liberates carbon dioxide from calcium carbonate. Assuming that it consists chiefly of monobasic humic acid with a molecular weight of 350, the gas liberated corresponds to 73 per cent. of humic acid in the dry substance. The peat in which the dopplerite was found liberates carbon dioxide corresponding to 60 per cent. of the dry substance.—Prof. W. F. **Barrett** exhibited and described Hilger's direct-reading wave-length spectroscope.—Prof. E. J. **McWeeney** gave a description of *Streptothrix nigra*, an organism occurring in soil, and producing a bright brown pigmentation of the nutrient medium.

Royal Irish Academy, May 25.—Prof. R. Atkinson, president, in the chair.—Reports were presented by Dr. R. F. **Scharff**, R. L. **Praeger**, Prof. G. A. J. **Cole**, Prof. D. J. **Cunningham**, F.R.S., G. **Coffey** and others on the results obtained during their exploration of the Kesh Caves, Co. Sligo. The reports detailed the results obtained from an exploration of the deposits of clay, rock-fragments, and stalagmite found in the caves situated on the slopes of Keishcorran Mountain in Co. Sligo. Several weeks were spent by the committee in excavating these caves in 1901. The zoological results possess many points of interest. The brown bear was found to have inhabited these caves in great numbers in former times; in Ireland remains of this animal have hitherto been found only very locally. The other animals found in the caves which are now extinct in the country in either a wild or domesticated state were the reindeer, wolf, and Arctic lemming, the last of which is an addition to the Irish fossil fauna. Man was chiefly a late inhabitant of the caves, a single polished axe being the only Neolithic object found. Several implements of crannog type were found, and abundance of charcoal.

June 8.—Prof. R. Atkinson, president, in the chair.—The intrusive gneiss of Tirerrill and Drumahair, by Prof. Grenville A. J. **Cole**. The northern end of the gneissic axis of the Ox Mountains consists of an intrusive granite, which contains blocks of amphibolite, derived from an earlier series. The banded phenomena presented by it are connected with its flow, and the contrasts of mineral constitution in the bands are connected with the abundance of basic inclusions, which have become streaked out in the fluidal mass. Though brought into their present prominence by Caledonian and Hercynian movements, the crystalline rocks of the chain may still be of Archæan age, as originally suggested by Prof. Hull.

PARIS.

Academy of Sciences, June 22.—M. Albert Gaudry in the chair.—Two fluid batteries; electromotive force, condensations, transformations of energy at the electrodes, by M. **Berthelot**.—On the structure and history of the lunar crust. Observations suggested by the seventh number of the photographic atlas of the moon, by MM. **Lœwy** and P. **Puiseux**. This volume contains photographs which show clearly the frequent distribution of the eruptive orifices along the lines of cleavage. From the mode of diffusion of the scoriæ there would appear to have been, at a remote period, an atmosphere, and from the state of these deposits it is clear that there can be no running water on the surface.—On the loss, in time of drought, of a spring fed by infiltration of a sheet of water, by M. J. **Boussinesq**.—On a property of the α-rays of radium, by M. Henri **Becquerel**. If the α-rays, placed in a field of magnetic intensity H, have a real or fictitious mass m, carrying an electric charge e, they ought to describe a circular trajectory of radius R, with a velocity v, and the relation $RH=vm/c$ ought to hold between these quantities. From this RH ought to be a fixed quantity for the α-rays, but this is not the case, since Prof. Rutherford has given $RH=3{\cdot}9\times10^5$, and in the experiments now described values of RH, varying continuously between $2{\cdot}91\times10^5$ and $3{\cdot}41\times10^5$, have been obtained. From this it follows that in a uniform magnetic field the radius of curvature of the trajectory of the α-rays deviated by the field increases with the length of the trajectory, and this may be attributed to the presence of air.—The preparation of carbides and acetylene acetylides by the action of acetylene gas upon the hydrides of the alkalis and the alkaline earths, by M. Henri **Moissan**. At a temperature of 100° C. the hydrides of the alkalis and the alkaline earths react with acetylene, liberating hydrogen and giving compounds of the type $C_2K_2.C_2H_2$ and $C_2Ca.C_2H_2$. These compounds, heated in a vacuum, dissociate readily into acetylene and the corresponding carbide, and hence form a new method for the preparation of the carbides at a low temperature. Neither methane nor ethylene react at 100° C. with these hydrides.—The influence of the solvent on the rotatory power of certain molecules, by MM. A. **Haller** and J. **Minguin**. Details are given of experiments on several camphor derivatives. In solution in benzene and its homologues, which are non-ionising liquids, the rotatory power of cyano-camphor was found to be nearly zero, whilst in other solvents, especially in alkaline liquids, which are strongly ionising, the rotatory power was very high. Other camphor derivatives showed similar results, although the differences were less marked.—The differences between

the diseases known as nagana, surra, and caderas, by MM. A. **Laveran** and F. **Mesnil.** It has been previously shown that the nagana or disease of the tsetse fly and caderas, prevalent in South America, are distinct diseases, and a comparison of the Trypanosoma from the disease known as the surra with the two preceding shows that this is quite different from either. The three diseases are hence quite distinct.—The international congress of savants at the Universal Exhibition of St. Louis, 1904, by M. **Newcomb.** This congress will be held on September 19, 1904, and the five following days. A short account is given of its objects and the arrangements that have been made.—The drawings on the walls of the cave of Altamira (Spain), by MM. Émile **Cartailhac** and the Abbé H. **Breuil.** A comparison is made between these drawings and those recently described in the French caves. The style of work and colouring is similar in both, but in the Spanish cave the colouring is much superior to that in the French caves; it is noticeable that in the former drawings of the mammoth and reindeer are absent.—Remarks by M. Salomon **Reinach** on the preceding memoir. It is noteworthy that only animals which could be used for food are depicted in these caves, there being no representations of carnivora. The Aborigines of Central Australia also draw figures of animals on the rocks and soil, with the object of increasing their multiplication, and here, also, carnivora are naturally absent.—The propagation of waves in elastic media, according as the media are conductors or non-conductors of heat, by M. P. **Duhem.**—The perpetual secretary announced to the Academy the death of M. L. Cremona, correspondant for the section of geometry. —On surfaces which may, in several movements, give rise to a family of Lamé, by M. A. **Demoulin.**—On the simultaneous employment of the laws of distinct survival, by M. Albert **Quiquet.**—On a method of measuring the variation of the current in the armature in short circuit during the time of commutation in a continuous current dynamo, by M. **Iliovici.**—On the physical constitution of the atmosphere, by M. Louis **Maillard.** The usual formula for the density $\rho=273/760\ p/T$ does not appear to hold when p and T are both very small. From the author's calculations, which are partly based on results from captive balloons and partly on laboratory experiments, the density of the air diminishes up to a height of 30 to 50 kilometres, and then increases up to 75 kilometres ($\rho=0\cdot21$). If these results are correct, the theories of astronomical refraction will require some modifications.—On the estimation of vanadium in alloys, by M. Paul **Nicolardot.** The method of Sefström (the solution of the alloy in sulphuric or hydrochloric acid) for the qualitative detection of vanadium in Swedish iron, when slightly modified, can be made quantitative. Comparative analyses of the same sample by three methods are given.—On the esterification of the hydracids, by M. A. **Villiers.**—On the benzoyl derivatives of hydrazobenzene, by M. P. **Freundler.**—On the action of abietic acid on ferments, by M. Jean **Effront.**—On some combinations of chloride of gold and pyridine, by M. Maurice **François.**—The phenyl substitution in the phenylmethanes, their carbinols and chlorides, by M. Jules **Schmidlin.** A thermochemical paper.—The preparation of alkyl nitrates and nitrites, by MM. L. **Bouveault** and A. **Wahl.** Excellent yield of nitric esters can be obtained by the use of anhydrous nitric acid in the case of the primary alcohols; with secondary alcohols the action is quite different, the corresponding ketone being the main product of the reaction; with tertiary alcohols the action is destructive. The action of pure HNO_3 is suggested as a reagent for differentiating between the three classes of alcohols. Excellent yields of nitrous esters were obtained by the action of nitrosyl chloride upon a mixture of the alcohol and pyridine at 0° C.—Chlorine derivatives of methylene chloroacetate and diacetate, by M. Marcel **Descudé.**—On some new members of the pyranic series, by MM. R. **Fosse** and A. **Robyn.**—On stachyose, by M. C. **Tanret.** It is shown that manneotetrose and stachyose are identical, the composition being $C_{24}H_{42}O_{21}$.—Comparisons between the phenomena of nutrition in seedlings with or without their cotyledons, by M. G. **André.**—On some conditions of oxidation of salicylic aldehyde by organs and extracts of organs, by MM. J.-E. **Abelous** and J. **Aloy.** The oxidation of salicylic aldehyde in extracts from the liver of the horse or calf goes on better in a vacuum than in air, the presence of free oxygen diminishing, or even suppressing, the oxidation.—On the glycerol in the blood, by M. Maurice **Nicloux.**—On mixtures of iodine and sulphur, by M. R. **Boulouch.** From a dilatometric study it would appear that sulphur and iodine when fused together give rise to neither definite compounds nor solid solutions.—The action of the magnetic field on the infusoria, by MM. C. **Chéneveau** and G. **Bohn.** Contrary to the results obtained by M. H. du Bois, it is found that an intense magnetic field modifies the ciliary movements, the growth, and the multiplication of the infusoria.—The law of the action of trypsin on gelatin, by MM. Victor **Henri** and Larguier **des Bancels.**—The family of the Clostridiaceæ, by M. Paul **Vuillemin.**—On the structure of the seed of *Nymphaea flava*, by M. J. **Chifflot.**—The disease of the plane tree, by M. J. **Beauverie.**—On the exotic plant species in the immediate neighbourhood of Béziers (Hérault), by M. P. **Carles.**—On the geology of the Oubangui district at Tchad, by M. **Lacoin.**—The poisons of the organism and gestation, by MM. **Charrin** and **Roché.**—The results of phototherapy and the technique of its application in lupus, by M. **Finsen.** Statistics of the results obtained in the treatment of lupus at the Finsen Institute, Copenhagen, with some details of the mode of treatment.

DIARY OF SOCIETIES.

FRIDAY, JULY 3.

INSTITUTION OF MINING ENGINEERS, at 11.30 a.m.—Further Remarks on the Portuguese Manica Gold-field: A. R. Sawyer.—Coal fields of the Faröe Islands: E. A. Greener.—Miners' Anæmia or Ankylostomiasis: Dr. J S. Haldane.—Water-softening Plant: Vincent Corbett.—The Redevelopment of the Slate-trade in Ireland: O. H. Kinahan.—The Smelters of British Columbia: W. Denham Verschoyle.—The Commonsense Doctrine of Furnace-draught: H. W. Halbaum.—The Ventilation of Deep Mines: Arthur C. Murray.

GEOLOGISTS' ASSOCIATION, at 8.—Some Flint Implements from Reading and Maidenhead: Ll. Treacher.

CONTENTS.

THURSDAY, JULY 9, 1903.

RECENT WORKS ON OPTICS.

Manual of Advanced Optics. By C. Riborg Mann, Assistant Professor of Physics in the University of Chicago. Pp. 196. (Chicago: Scott, Forseman and Co., 1902.)

Practical Exercises in Light: being a Laboratory Course for Schools of Science and Colleges. By R. S. Clay, B.A., D.Sc. Pp. vi+187. (London: Macmillan and Co., Ltd., 1902.) Price 2s. 6d.

Elementary Ophthalmic Optics. By Freeland Fergus, M.D., F.R.S.E., Surgeon to the Glasgow Eye Infirmary. Pp. viii + 107. (London: Blackie and Son, 1903.) Price 3s. 6d. net.

Geometrical Optics: an Elementary Treatise upon the Theory, and its Practical Application to the more Exact Measurements of Optical Properties. By Thomas H. Blakesley, M.A. Pp. viii + 120. (London: Whittaker and Co., 1903.) Price 2s. 6d.

Das Stereoskop. Seine anwendung in den technischen Wissenschaften. Über Entstehung und Konstruktion Stereoskopischer Bilder. Von Wilhelm Manchot, Architekt und Professor am Städel'schen Kunstinstitut zu Frankfurt a.M. Pp. vi (3 blank)+ 68. (Leipzig: Veit and Co., 1903.)

MR. MANN'S book contains an account of the three months' experimental course on optics pursued by the senior students at the University of Chicago. The name Chicago, uttered on this side of the Atlantic, suggests many different things to different persons; to physicists it cannot but bring to mind the name of Prof. Michelson, to whom we are indebted for some of the most valuable and ingenious optical investigations that the last century brought forth. An experimental course, developed according to the ideas of Prof. Michelson, could scarcely be other than original and stimulating; the course before us, in addition, is systematically developed, the descriptions are clear and concise, and the illustrations, though few, are well calculated to serve the purpose for which they were intended. Each chapter commences with a brief theoretical investigation, wherein the aim is to concentrate attention on the physical, as distinguished from the purely mathematical, aspect of the subject; following this is a description of the experiments, and the manipulation of the necessary apparatus. Room is left for the student to develop a certain amount of originality in his methods, and thus avoid reduction to the state of a mere mechanical copyist. Numerous references are given to original memoirs, which should prove very useful to advanced students. Besides the experiments usually found in books on optics, descriptions are given of the method of determining the resolving power of telescopes, spectroscopes, and gratings. It is interesting to find Prof. Michelson's classic researches on the resolution of spectral lines by means of the interferometer included in a course for students. In fine, no one on glancing through this book would hesitate to endorse the concluding words of Prof. Michelson's introductory note:—

"Those who desire to enter into optical investigations cannot get a better foundation for future work than by studying the optical theories here presented, and performing the experiments described."

Teachers have long felt the want of an inexpensive book on practical light, suitable for students who are commencing the study of the subject; and to these Dr. Clay's little book may be confidently recommended. As stated in the preface, it forms the elementary portion of a "Treatise on Practical Light," now in preparation by the author. It is by no means an easy task to arrange a series of elementary experiments on light, which shall be sufficiently varied to prevent the interest of the student from flagging, while of sufficient scope and completeness to give the student a firm grasp of the elementary principles of the subject. The author is to be congratulated on his success in both the above respects. The ordinary laws of reflection, refraction, and dispersion are illustrated by the aid of simple experiments, which can be performed without the aid of expensive appliances; indeed, the spectrometer is the only piece of elaborate apparatus required for the course described. In addition, numerous practical exercises are appended at the ends of the chapters. Attention is directed to the observation of caustics, and the principle of formation of the rainbow. The optical bench described by the author is to be commended for its simplicity and efficacy. Perhaps the most novel part of the course consists in a number of experiments on the optical properties of the eye, and others on diffraction and interference. We do not remember to have previously seen a description of the method of producing Lloyd's single mirror fringes by the aid of a prism and spectrometer. Points to which objections can be raised are neither numerous nor important. On p. 86, it is stated that a telescope focused for infinity and directed towards the sun gives rise to a parallel bundle of emergent rays. This is scarcely correct; the rays from any particular point of the sun will emerge parallel to each other, but the total emergent light consists of a diverging bundle of pencils, each consisting of parallel rays. On p. 127, it is stated that the *fovea centralis* contains rods only and no cones, while the reverse is actually the case. The account given on p. 132 of the mechanism of accommodation could bear revision; modern research indicates that the increased curvature of the anterior surface of the crystalline lens is produced by an increase of tension in the anterior capsule layer, and not by its relaxation, as was supposed by Helmholtz.

The opththalmic surgeon has to deal with the eye, not alone as a delicate organ of the human body, subject, like other organs, to disease; but also, in many cases, as a defective optical instrument. Hence a knowledge of optics is as necessary to him as an acquaintance with the science of electricity is necessary to the electrical engineer. Dr. Fergus's book has been written for medical students, as an elementary introduction to the science of geometrical

optics. There are few points in this book calling for remark, except, perhaps, the very arbitrary limitations of the subject-matter. Thus, chromatic aberration and dispersion, the "power" of a lens and its measurement in dioptres, the use of lenses as spectacles or magnifying glasses, and the optical system of the eye itself, alike remain unmentioned. The mathematical theory of thick lenses is discussed, although the subject of lens combinations is neglected. No experimental methods with regard to lenses are described, and no problems for solution by the student are appended.

In taking up the study of light, students generally commence with the laws of geometrical optics. Further on in their studies they find that the instruments used for even the simplest investigations comprise various combinations of lenses and mirrors, which can be understood and appreciated only when a competent knowledge of geometrical optics has been acquired. In spite, however, of the manifest importance of this branch of knowledge, it has in recent years received scant attention from investigators, and has shown few marks of progress. This is undoubtedly due in part to the fact that the subject of geometrical optics affords a happy hunting-ground for the mathematician, who may, or may not, have anything more than a passing acquaintance with the practical side of the subject; while the attention of experimental investigators has mostly been absorbed in other directions. Let us consider, for instance, the subject of lens combinations. Gauss showed that a thick lens, or combination of lenses, possesses four important points on the axis—the two principal points and the two principal foci. If the distances of the object and image are respectively measured from the first and second principal points, then the formula for the combination takes a form similar to that applicable to a single thin lens. In a sense, then, the work of Gauss affords a complete method of solving any problem connected with lenses; it labours under the disadvantage, however, that in most problems the necessary analysis is of a somewhat clumsy character. It has thus been left for Mr. Blakesley to introduce a remarkable simplification, by measuring the distances of the object and image, not from the first and second principal *points*, but from the first and second principal *foci*. The resulting equations in u and v, as well as those relating to the magnification, now take forms amenable to simple analytical treatment. The focal length of a lens, or lens combination, is taken as a constant of one dimension in space, not necessarily measured from any particular point; in this respect it resembles the coefficient of self-induction of a coil.

The advantage of this method is well illustrated by the investigation on the combination of a lens and a mirror, on pp. 67–71. It also readily adapts itself to the needs of experimental investigations. A distinguishing feature of the book is the attention devoted to practical determinations of the constants of lens systems; those involving the use of a microscope are particularly worthy of remark, though all are interesting. It is to be regretted, however, that Mr. Blakesley has preferred to speak of Gauss's principal points as "the points 1 of the diagram"; a section on the graphical construction of images, using Gauss's principal planes, would also make many problems clearer. In view of their practical importance, with respect to the optical system of the eye, Listing's nodal points also claim some mention. Chapter xi., on forms of lenses for minimum deviation of rays, is of great interest and practical importance. It is to be feared, however, that the geometrical relations of circles, which are cursorily alluded to in the text as "quite clear," may greatly puzzle many students whose leaning is toward practical physics rather than toward pure mathematics. Further, the theory of the achromatisation of an eye-piece (p. 110) could bear amplification. Many students arrive at the conclusion that Huyghens's eye-piece has advantages, with respect to ordinary chromatic aberration, over a single thin lens used as a magnifying glass—a conclusion which is demonstrably erroneous. Mr. Blakesley gives data from which a student, if sufficiently enthusiastic and persevering, might arrive at the truth of this matter; but a page or so devoted to the question would have enhanced the value of the book. It is further to be regretted that a series of problems, to be solved by the student, has not been appended; a loose leaflet containing five such problems, issued as advertising the scope of Mr. Blakesley's book, shows how attractive work of this kind may be made. Finally, however, it must be said that a more interesting and stimulating book than that under consideration is seldom likely to come in the way of the student. Mr. Blakesley has, moreover, effected a notable advance in geometrical optical theory.

The stereoscope is probably mentioned, more or less briefly, in most lecture courses on optics; but it is seldom realised that this instrument is something more than a plaything or a scientific curiosity. Yet it is undeniable that, in many branches of science, the stereoscope could be used as a most valuable aid to instruction. In commencing the study of analytical geometry of three dimensions, for example, the chief difficulty of a student is to realise the actual significance of the more or less conventional diagrams which he must use; there can be little doubt that, if provided with proper diagrams to be viewed stereoscopically, he would avoid much profitless labour, and gain, in the end, much clearer notions of the significance of the processes employed. In practical solid geometry, architecture, crystallography, &c., there are other wide fields for the use of the stereoscope. Prof. Manchot mentions a further novel use to which the stereoscope can be put. If two bank notes are viewed stereoscopically, slight differences, which could scarcely be detected by the eye, will give the printing an appearance of relief or depression, so that a false note can easily be detected.

That the stereoscope is not more largely used is doubtless due to the fact that, in the forms ordinarily met with, the pictures or diagrams are limited to too small a size for the full benefit of the instrument to be felt. Prof. Manchot has invented a stereoscope which can be adapted to viewing diagrams of any size whatever, and this instrument is fully described

as well as the method of constructing stereoscopic diagrams to be used with it. To those anxious to lighten, so far as possible, the labour of the student, while increasing the efficiency of the teacher's efforts, Prof. Manchot's little book should afford suggestive reading. EDWIN EDSER.

PREVENTION OF ACCIDENTS IN FACTORIES.

Infortuni sul lavoro. Mezzi Tecnici per Prevenirli. By Ing. E. Magrini. Pp. xxxi+251. (Milano: Ulrico Hoepli, 1903.) Price L.3.

THE introduction opens with this apt quotation, "Le fabricant doit autre chose à ses ouvriers que le salaire." And the book purposes to teach the manufacturer how to pay the debt by providing all the protection possible against dangers attending the use of machinery.

The prevention of accidents is a subject to which much attention has been given in Italy, first by the "Associazione per prevenire gli infortuni sul lavoro," and finally by the Government, which completed its legislation in 1899 by the issue of a set of precautionary rules incumbent on all users of machinery. These rules form the framework of the book, each chapter having, as text, an extract from them, and describing in detail the appliances needed to give effect to the regulation in the various classes of machinery.

The first two chapters deal with prime movers, the means of fencing them and of stopping them, not merely by cutting off the motive power, but by applying brakes to the moving parts. Transmissions—shafts, belts, gears, &c.—form the subject of chapter iii., and share with circular saws (chapter v.) the distinction of causing more accidents than any other class of apparatus. A comparison of these two chapters is instructive. Of all protective devices, those for circular saws have called for most ingenuity and met with least success. The numerous coverings described are costly and complicated without being really effective, and they are devices which a workman would discard whenever possible. On the other hand the protections described in chapter iii. are simple, effective, and devoid of any hindrance in working, and call for more attention than they usually receive. Carding and spinning machines, emery wheels, ladders and protective clothing, spectacles, &c., are dealt with briefly, while elevators of all kinds and their safety appliances are discussed fully. In chapter vii. forty pages are devoted to the dangers of manœuvring with belts in motion. Much in this is of great value, many of the devices being as simple as they are effective.

Electrical machines, fires and boilers receive very inadequate treatment in the remaining twenty-five pages. The chapter on electrical machinery does not approach the standard of the rest of the book; it is far from complete, even on more important points, and contains many statements and recommendations that would find but little acceptance from engineers.

Speaking of the book as a whole, it tends rather towards a catalogue; more critical descriptions of the different devices would have been welcome, and this more especially in regard to two important points, which are almost entirely overlooked. These are, firstly, that a device which does not afford complete protection often increases the danger; it lulls to a sense of false security. Secondly, that a protection which can be discarded by the workman is of far less value than one which he is forced to adopt. Most safety devices are of some hindrance in working, and experience shows that workmen take no interest in efforts made for their protection; they are merely annoyed at the inconvenience in their work.

These few criticisms are easily outweighed by the praise which the book well deserves. Nearly all the devices are illustrated as well as described, and in matters of detail the book gives numberless useful hints, and what may be termed dodges rather than appliances; a master, by following these, could avoid many dangers at little cost and trouble.

G. H. BAILLIE.

A NEW SWISS HANDBOOK.

Guide to Switzerland. Pp. cvi + 235; with 31 maps and 6 plans. (London: Macmillan and Co., Ltd., 1903.) Price 5s. net.

MODERN tourists, and in particular those who wander in companies, are prone to haunt certain familiar centres, Lucerne, Grindelwald, Zermatt, Chamonix, Pontresina, and to confine their excursions within narrow bounds. Messrs. Macmillan have designed a handbook to meet the needs of this class. In many respects the conception of the volume is good, but the execution is faulty and unequal. To deal first with its merits. The eulogy of the political institutions of the Swiss Republic, and the notes on the nature of glaciers, introduced among the preliminary chapters, ought to interest and inform the better class of sight-seers, while practical suggestions on health and outfit are useful to all. The separate hotel list will be found convenient for reference; houses frequented by our countrymen are distinguished by larger type, and prices are in many cases quoted. As a whole, the list seems to be compiled with care, but there are singular omissions; amongst them we have noted Binn, St. Beatenberg, Montana, Piora, Promontogno, Lanzo d'Intelvi, all well-known stopping places. At Binn, the text tells us, "refreshments can be procured, and if necessary beds obtained at the Curé's." The village has for years had a large hotel with an English chaplain attached. The inns on the tour of Mont Blanc, at Contamines, Nant Borrant, Chapieux, are mentioned in the route, but not in the list.

When we come to study in detail the guide-book proper, we find that the routes have been conveniently arranged round the centres to which they naturally attach themselves. The editors recommend their text as "concise and accurate." As to accuracy, we cannot endorse their estimate of their work. The section relating to Davos is well done, but that devoted to the Upper Engadine is meagre and untrustworthy. The new railway connecting Thusis and St. Moritz by the Schyn and Albula, opened to Celerina this year, ought to have been described. Promontogno, with its good hotel, the natural halting-place for travellers

coming from the Lake of Como, and the exquisite drive to Soglio, are passed over. The "Palace Hotel" at Maloja has its prospectus printed almost in full, but many of the excursions from it are catalogued under Sils. The carriage roads up the Fex Thal and Roseg Thal, the restaurants at Curtins, on the Surlei Furka, Piz Languard, and elsewhere, are left out, though in other districts restaurants are noted. The Bernina Hospice and Bernina Houses have been confused. The inn at the foot of the Morteratsch Glacier and that on the Diavolezza Pass, the latter the best starting point for many peaks and passes, are ignored. The way to Boval is said to be "rough and over snow"; there is an excellent path; so there is, since 1902, up Piz Julier, said to be "difficult." The Alp Misaun is suggested as a starting point for Piz Morteratsch. No travellers prefer its hay to the good accommodation offered by the Roseg Inn or the much higher Tschierva hut.

It is an easy task to pick holes in a guide-book covering such an extensive field as Switzerland. We have preferred to collect our bundle of blunders almost entirely from a single district. We could easily have made it bigger without going farther, and by extending our survey we might fill columns. But enough has been done to warn travellers who may be tempted by the numerous and, as a rule, excellent maps to purchase this volume that they must not rely on its information as regards either ordinary excursions or glacier expeditions. Nor in many cases can we at all agree with the editors' estimates of scenery. We should hesitate to call the Bel Alp "a beautiful and secluded village," or to characterise "the scenery round the Borromean Islands" as "strikingly grand." The index stands in need of careful revision.

OUR BOOK SHELF.

The Fauna of British India, including Ceylon and Burma. Published under the Auspices of the Secretary of State for India in Council. Edited by W. T. Blanford. Hymenoptera. Vol. ii. Ants and Cuckoo-Wasps. By Lieut.-Colonel C. T. Bingham. Pp. xix+506. (London: 1903.)

THE first volume of this work appeared in 1897, and included the wasps and bees, and now the second volume has been issued, containing the still more interesting family of the Formicidæ, and also the small, but very beautiful, family of the Chrysididæ, or ruby-tail wasps; or, as Colonel Bingham calls them, the cuckoo-wasps. This completes the important section of Aculeata, or stinging Hymenoptera, and the monographing of the remaining groups, which are still very imperfectly known, is very properly deferred for the present. We are, however, pleased to see that Colonel Bingham has undertaken to prepare a work on the butterflies of British India for the same series.

Colonel Bingham divides the Formicidæ into five subfamilies, Dorylinæ, Ponerinæ, Myrmecinæ, Dolichoderinæ, and Camponotinæ (498 species); and Chrysididæ with four subfamilies, Cleptinæ, Ellampinæ, Chrysidinæ, and Parnopinæ (79 species). When we remember that instead of 498 species of Formicidæ there are only about forty species in Britain, and only about a hundred in all Europe, the difference between a temperate and a tropical fauna becomes sufficiently obvious.

A very clear account of the external characters of ants is given in the introduction, elucidated by numerous figures of structure. The bulk of the work is almost exclusively descriptive, but includes useful keys to genera and species, synonymy, and occasional notes on habits. Exigencies of space necessitate the latter being of the utmost brevity, which, though obviously unavoidable, is none the less to be regretted, for the habits of many Indian ants are extremely interesting.

The 577 species described by Colonel Bingham in the volume before us are illustrated by 161 text illustrations, frequently including structural details as well. Occasionally more than one species of a genus is figured. A coloured plate is added, with sixteen coloured figures of Chrysididæ. Among the most interesting of the uncoloured figures are those representing the curious spiny ants of the genus Polyrhachis.

Comparatively few new species are described, for much has been written on Indian Formicidæ in recent years. But, except as regards the obsolete catalogue of F. Smith, almost all that has been published is scattered through a variety of scientific periodicals not always easy of access, and we congratulate Colonel Bingham on the completion of a comprehensive work which must greatly facilitate the study of his subject to all future workers.

Dendrologische Winterstudien. Von Camilla Karl Schneider. Pp. vi+290. (Jena: Gustav Fischer, 1903.) Price 7.50 marks.

THE study of our tropophytic trees and shrubs in their winter condition has been somewhat neglected from the systematist's point of view. While such works as those of Sargent and Willkomm have hitherto supplied the wants of the forester, still the number of species they deal with is limited, and a more extended list is required. To meet this want the author of the above work has set himself no small task, and, in our opinion, has achieved a degree of success which only great patience and perseverance could attain. The book deals with 235 genera, including 434 species of indigenous and introduced deciduous trees and shrubs in Europe. A notable feature of the work is the large number of illustrations, 224 in all, which are reproduced from photographs and hand drawings of actual specimens.

The subject-matter is divided into three sections—a general, a special, and a systematic. The first section deals with general organography, and gives a wide and comprehensive survey of the subject. The reader is thereby well prepared for what is to follow in the next section, which is the bulkiest and most important one in the book. It is devoted to the special consideration of the various species in their winter condition. The descriptions are short and concise, many abbreviations being used, which are, however, fully explained at the beginning of the section. The accompanying figures, which illustrate the salient features of the species described, are very instructive and well drawn. The author attaches more importance to good figures than to descriptions, and has consequently produced a large number of drawings which alone would, in most cases, amply suffice for purposes of identification and comparison. The classification of the leafless twigs is somewhat intricate, but this is unavoidable when a large number of species has to be tabulated. Following this comes a section giving a systematic arrangement of the various species dealt with. The system adopted is that of A. Engler.

In the bibliography at the end, the more important dendrological works are cited, and a short statement of their contents given.

The work is primarily a contribution to systematic dendrology, and cannot fail to be of interest and value to the systematist. At the same time, the subject is of considerable importance to the practical man, be he nurseryman, forester, gardener, or landscape gardener. In those professions winter operations often occur, in which it is very important to be able to identify accurately the different species.

The special descriptions of the species dealt with in the book, so far as they have been tested, have proved to be quite accurate. There are a few misprints and slips, which are, however, corrected in the errata at the end of the book. There are one or two emendations still required, such as "*Spartium junceum*" instead of "*Sportium unceum*," p. 22, line 3. Also in the reference to the wood body of Fig. 31, given on p. 56, line 33, we would substitute "undermost layer" for "uppermost layer." However, such slips will, no doubt, disappear in a second edition, which we hope to see this work reach, and in which the author will be able to enhance the value of his work by the addition of still more species.

La Tecnica delle Correnti Alternate. Vol. i. Parte qualitativa e descrittiva. By G. Sartori. Pp. xv+336; 260 illustrations. (Milano: Ulrico Hoepli, 1903.) Price L.8.

THE course of evening lectures read before a class of artisans is here given in book form. Except for an occasional algebraic expression, mathematics are rigidly excluded, and yet the author tackles the most complex phenomena of alternate currents, and discusses the behaviour of synchronous, asynchronous and rotary-field motors, with their various starting devices; of rotary converters and their tendency to hunt; of alternators running in parallel, and of wave propagation in long lines. And he does this with so much success that the usual treatment on the basis of a sine wave-form compares unfavourably. A mathematical treatment of the subject is practicable only on the assumption of sine-waves, and the evil of this is that students are apt to forget that in practice the wave-form is rarely sinusoidal, and generally so far removed from it that the theoretical deductions are then valueless. To deal with alternate currents is far harder without than with the use of sine waves, and the author is to be congratulated on his success. The book, in fact, is not an elementary manual, but an up-to-date treatise, its language suited to the artisan and its substance to any student.

Monographie des Cynipides d'Europe et d'Algérie. Par l'Abbé J. J. Kieffer, Membre de la Société Entomologique de France. Tome Second. Premier Fascicule. Pp. 288; avec les planches 1 à 9. (Paris: Hermann, 1903.) Price 16 francs.

THIS is another instalment of the important series of monographs forming part of the great work on Hymenoptera inaugurated by the brothers André. It includes the portion of the parasitic Cynipidæ comprised in the tribes Allotriinæ, Eucœlinæ, and the commencement of the Figitinæ. The Allotriinæ must be regarded as very useful insects, for they feed chiefly, if not exclusively, on Aphidæ and Coccidæ; whether they ever attack other insects seems for the present to be somewhat uncertain. The Eucœlinæ, on the other hand, are parasites on the larvæ and pupæ of Diptera, and sometimes on small Coleopterous larvæ, and the single recorded instance of their attacking Aphidæ is considered by Kieffer to require confirmation, while the known larvæ of the Figitinæ are parasitic on the larvæ of Diptera, Coleoptera, and Neuroptera.

The subject is treated in a similar manner to that of the first volume, which we have recently noticed, and several species are described as new. The former standard of excellence is well kept up, both as regards the text and plates.

Spirals in Nature and Art. By Theodore Cook. Pp. xxi+200. (London: John Murray, 1903.) Price 7s. 6d. net.

THAT spiral curves, or, more strictly, helices, and screw motions should play an important part both in the natural world and in structures constructed by human hands is a fact for which a mathematician can easily suggest an explanation on general grounds. Without professing to bring any extensive scientific or technical knowledge to bear on the subject, Mr. Cook has made a most interesting study of the resemblances between the spiral forms occurring in nature and in art, and has produced a book the study of which will be a delightful recreation to any class of reader. Apart from the mere spiral form, Mr. Cook finds remarkable resemblances between the structure and sculpturing of certain staircases in France and those of the shells of certain mollusca. It is certain that Leonardo da Vinci studied shells, and that he was in France about the time when these staircases were built, and an obvious connection suggests itself. While the author's study of the works of Leonardo da Vinci—illustrated by copies of his drawings—is interesting, the connection of Leonardo's studies of the flight of birds with spiral curves strikes a reader as somewhat doubtful. Even Pettigrew's figure-of-eight-shaped curve, and the oval curve familiar to readers of Marey's "Vol des Oiseaux," which represent, according to modern views, the relative paths of points on the wings of a wasp and a bird, can hardly be said to produce a *spiral* curve when compounded with the forward motion of the animal.

Lois générales de l'Action des Diastases. Par Victor Henri. Pp. xi+129. (Paris: A. Hermann, 1903.)

AFTER a general introduction on catalysis and a classification of catalysers, the author gives a historical account of the work already done on the action of diastases. Then follows a description of his own researches on the action of invertase on cane-sugar, together with the theoretical deduction of a formula which represents with considerable accuracy the actual course of the reaction under varying conditions of concentration. The book concludes with two short chapters on the action of emulsin on salicin, and of amylase on starch. The author shows an intimate acquaintance with the mode of application of the laws governing the velocity of chemical action, and has been successful in selecting appropriate experiments to solve the problem with which he was confronted.

Sylviculture. By Albert Fron. Pp. xii+563. (Paris: J. B. Baillière et Fils, 1903.) Price 5 francs.

THIS is one of the volumes of the useful "Encyclopédie Agricole" which is appearing in France under the auspices of a "Réunion d'Ingénieurs agronomes." It deals succinctly with the methods of cultivation of woods for commercial purposes, gives an account of the chief timber trees, and also deals with the products of forests and the manner of their conversion, in accordance with French practice.

The book has no special feature. It is well adapted to the requirements of students of the "École Nationale d'Agriculture," for whom it is intended, and forms a useful addition to its series without replacing the larger text-books on the forestry of France—such as those of Boppe.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Radium and Solar Energy.

THE extraordinary discovery that radium has the property of continuously radiating heat without itself cooling down to the temperature of surrounding objects may possibly afford a clue to the source of energy in the sun and stars.

Taking the Curies' observation that one gram of radium can supply 100 calories per hour, I thought it would be of interest to compute how much radium would suffice to supply the sun's output of energy.

Taking from Langley's observations that this is equal to 828,000,000 calories per square cm. per hour, I find that 3·6 grams of radium per cubic metre of the sun's volume would supply the entire output.

It may be possible that at solar temperatures radium is capable of much more energetic radiation, and, if so, the 3·6 grams might be reduced to a much smaller figure.

Daramona, July 1. W. E. WILSON.

"Red Rain" and the Dust Storm of February 22.

IN a letter under the above heading which you did me the honour to print in your issue of May 21, vol. lxviii. p. 53, I gave the results of the chemical examination of a sample of dust collected from the roof of Bayham Abbey, Lamberhurst, after the dust storm of February 22, and sent to me by the kindness of Lord Camden, and I stated that it would be interesting to compare its characters with those of the dust, presumably of African origin, which was observed to fall in the district of Taormina by Sir Arthur Rücker, and was the subject of an interesting communication to NATURE by Prof. Judd in 1901 (vol. lxiii. p. 514).

Thanks to the kindness of Prof. Judd, who sent me about a gramme of the Taormina dust collected by Sir Arthur Rücker and placed among the geological specimens at South Kensington, I have been enabled to make the comparison.

In external characters the Taormina dust closely resembles that from Bayham Abbey. Its microscopical features are also generally similar.

Mr. C. Simmonds, of the Government Laboratory, to whom I am indebted for the analyses already published, found that after drying at 100° C., the sample had the following composition:—

	Per cent.
Silica	36·32
Alumina	16·35
Ferric oxide, with traces of manganese oxide	6·08
Cobalt oxide	0·32
Lime	6·24
Magnesia	2·21
Sodium oxide	2·59
Potassium oxide	2 72
Water and organic matter	23·49
Chlorides and sulphates	traces
Carbonic acid	3 68
	100·00

The cobalt oxide may include a little nickel, but the quantity was too small to identify with certainty.

After being heated to redness, 28·08 per cent. of the sample was dissolved on boiling with dilute hydrochloric acid, the soluble constituents being:—

	Per cent.
Silica	0·88
Alumina	10·16
Ferric oxide	5·52
Lime	6·24
Magnesia	2·21
Alkalis	2·57
Carbonic acid (by difference)	0·50
	28·08

The organic carbon in the sample amounted to 9·89 per cent., and the organic nitrogen to 0·16 per cent. This small proportion of nitrogen shows that the organic matter is mainly, or entirely, of vegetable origin. Calculated from the mean proportion of carbon in cellulose and humic acid, the amount of organic carbon present in the sample would correspond to about 19 per cent. of organic matter, or, from cellulose alone, to 16½ per cent.

A comparison of the dust from Taormina with the "red rain" dust from Bayham Abbey may be made by calculating the inorganic constituents as percentages on their sum, after deducting water and organic matter:—

	Taormina Dust. Per cent.	Bayham Abbey Dust. Per cent.
Silica	47·47	50·53
Alumina	21·37	20·18
Ferric oxide	7·94	7·23
Cobalt oxide	0·42	—
Lime	8·16	9·50
Magnesia	2·89	2·04
Sodium oxide	3 38	1·27
Potassium oxide	3·56	2·53
Carbonic acid	4·81	6·72
	100·00	100·00

Reduced thus to a common basis for comparison, the inorganic portions of the two samples show a general similarity of composition, the chief differences being that the Bayham Abbey specimen contains a little more silica and chalk, and a little less alumina and alkalis, than the sample from Taormina.

The constituents soluble in dilute hydrochloric acid may similarly be compared, after deducting carbonic acid and raising the figures to percentages:—

	Taormina Dust. Per cent.	Bayham Abbey Dust. Per cent.
Silica	3·19	2·28
Alumina	36·84	39 93
Ferric oxide	20·02	19·35
Lime	22·62	29·20
Magnesia	8·01	4·03
Alkalis	9·32	5·21
	100·00	100·00

It is of interest to compare the foregoing results with an old analysis by Gibbs of dust which fell on a ship in the Atlantic (*Pogg. Ann.*, lxxi., 367). After deducting 18·53 per cent. of water and organic matter, the composition was found to be as follows:—

	Per cent.
Silica	45·58
Alumina	20·55
Ferric oxide	9·39
Manganic oxide	4·22
Calcium carbonate	11·77
Magnesia	2·21
Potash	3·64
Soda	2·33
Cupric oxide	0·31
	100·00

Except for the presence in this sample of a notable quantity of manganese and copper, the analysis bears a close resemblance to that of the Taormina dust; the fact of the similarity is particularly interesting, considering that something like half a century has probably elapsed since Gibbs's sample was collected.

Mr. J. J. H. Teall, the director of the Geological Survey, kindly sent me a sample of "blood rain" dust which fell at Palermo at about the same time as the dust from Taormina collected by Sir Arthur Rücker. This closely resembles the Taormina dust in general characters. Mr. Teall has suggested that the question of the origin of the dust might be elucidated if the samples were found to contain free aluminium hydroxide. The bearing of this upon the question of origin is as follows:—Evidence has been recently adduced to show that laterite, a decomposition-product of the felspars, is an aluminium hydroxide, though always mixed with more or less silica. This type of decomposition, it is believed, occurs only in tropical regions, and hence the presence of uncombined alumina in the dust

if it could be established, would be evidence of tropical origin.

Following out Mr. Teall's suggestion, the Taormina sample, and also the one from Bayham Abbey, have been examined to see if any evidence could be obtained showing the presence in them of aluminium hydroxide. A study of the actions of solutions of caustic and carbonated alkalis upon the dusts showed that both silica and alumina could be dissolved from them by the former solvent; but similar results were also obtained from orthoclase and oligoclase, whilst the treatment with sodium carbonate showed that no large quantity of amorphous silica was present in either of the specimens. The results are not conclusive, but, so far as they go, they point to there being no uncombined alumina in the samples. T. E. THORPE.

Dust Storms in New Zealand.

AN event of more than ordinary interest occurred here last November, and seeing that it has a certain importance not altogether restricted to us and our neighbourhood, I have ventured to address you on the subject.

From Invercargill, at the extreme south of the South Island, it was reported on November 14 that in various parts of the town and district tank water had a clayey appearance, and exposed objects were covered with a fine dust or mud. A similar report came from many places in the south-east portion of the island, and inland as far as Wakatipu, where heavy gales and thunderstorms are stated to have occurred on that date. At Dunedin no sign of the dust was visible during the day, but in the evening, from 8 to 10 p.m., the moon was at times obscured by clouds of a reddish colour, but the weather kept dry and no dust fell. At Waipawa, near the east coast North Island, a very heavy dust storm commenced at 9 a.m. on November 15. It lasted for several hours, extended, and became very thick. It was not due to local causes.

Samples of the dust examined by a local authority in Dunedin were stated to be of volcanic origin, and possibly connected with eruptions in Samoa or in South Victoria.

Dr. Benham, of the Otago University, kindly gave me a sample of the dust that fell at Otakaia, a few miles south of Dunedin. I submitted it to microscopical and chemical examination with the following result:—

The specimen was in a small bottle with water; it had fallen into a bucket which was quite clean, and in such a position that contamination was impossible. The sediment was of a reddish-brown colour, very fine in grain. A mounted specimen examined with an ⅙-inch objective showed various vegetable cells, apparently portions of the feathery pappus of fruits of composites and similar light matter. Small rounded grains of inorganic matter were frequent, in some cases large enough (0·03mm. diameter) to depolarise light. They were chiefly quartz, but some were apparently augite, and others particles of weathered minerals coloured red with iron oxides. To these last the colour of the dust in mass was due. There were also in every preparation observed several diatoms. In one preparation there was a piece of vegetable tissue composed of fine cells. In all there was much carbonised matter. A partial quantitative analysis gave the following result after complete drying in an air bath:—SiO_2 53·68, Al_2O_3 18·44, Fe_2O_3 6·54, CaO 0·95, MgO 1·52, K_2O 2·58, Na_2O 1·67. Loss on ignition, 14·60. Total, 99·98. I have been unable to find any analysis of dust borne any great distance by wind with which to compare this. A partial analysis of dust collected in England, given in a March number of your paper, does not differ much from this except that the loss on ignition is 36·4, and the other constituents correspondingly lower.

There is no doubt that this dust was derived from a desiccated surface; the carbonised matter suggests that it had been swept by fire, and as the weather all over New Zealand had been very wet for weeks previously, there is no possibility of a local origin of the dust.

Since Australia had just previously, after a period of most prolonged drought, suffered from the effects of severe gales, causing dust storms that produced almost total darkness in Melbourne and Sydney, it is natural to look to that continent for the origin of the dust storm. Through the kindness of Prof. J. W. Gregory, F.R.S., I was sent a specimen of dust that fell in Gippsland during a dust storm on October 11, and this, though coarser, was so essentially similar to our dust that a comparison of the two specimens at once established the extreme probability of identity of origin.

The distance in a straight line from Melbourne to Invercargill is 1200 miles, and to Dunedin 1300 miles, and from Sydney to Waipawa 1300 miles. The origin of the dust was probably some distance to the west of the Blue Mountains. There seems, therefore, no doubt that this dust was carried 1500 miles, 1200 of which was over a water surface.

Your readers are doubtless aware that the climate of New Zealand, and of Australia on its eastern seaboard, is chiefly dependent on the passage of deep cyclonic disturbances travelling in a general N.W.–S.E. direction. In front of the centre of these the wind blows strong from the N.W., and behind the centre from the S.W. The barometrical and weather records appended show that at the date mentioned such a cyclonic disturbance of rather more than the average intensity was experienced at the time of the dust fall.

In connection with this I may mention that after the famous "Black Thursday" in Melbourne, Dunedin and the southern portion of the south island of New Zealand generally experienced a dense smoke, and comparatively large fragments of carbonised vegetable matter fell.

In conclusion, I should like to point out the significance of such an observation as this in connection with the distribution of plants in the Southern Hemisphere. Since diatoms and vegetable particles of recognisable size were present in the very small portion of the dust examined, it seems quite possible that in the large total of dust that fell some of the smaller and lighter seeds of Australian plants may have been present.

Date, 1902.	Barometer Brisbane.	Barometer Sydney.	Barometer Melbourne.	Barometer Adelaide.	Direction Hobart.	Barometer Hobart.	Direction Dunedin.	Barometer Dunedin.
Nov. 11	30·08	30·01	29·91	29·95	—	—	N.W.	29·72
Nov. 12	30·09	29·96	29·78	29·61	S.E.	29·9	S.W.	29·50
Nov. 13	29·96	29·53	29·63	30·03	W.	29·3	S.W.	29·82
							N.W. to S.W.	29·42
Nov. 14	29·98	29·90	30·04	30·27	—	—	N.E. to S.W.	29·50
Nov. 15	—	30·13	30·14	30·18	—	—	S.W.	29·92

P. MARSHALL.

Otago University, Dunedin, New Zealand, May 3.

Science and Naval Promotion.

THE friends of the advancement of science in the Navy can hardly fail to be very pleased with the recognition it has received in the recent promotions to the rank of commander. Of the twenty-seven lieutenants promoted on June 30 last, twenty-one were "specialised officers." In a batch of promotions such as this there is much to encourage our best officers to direct their attention to the more scientific work of their profession, yet one cannot but remark upon a feature in the analysis of these promotions, namely, the marked difference in the average times these new commanders remained lieutenants. Thus, three lieutenants (T) averaged 10 years; nine lieutenants (G) averaged 10·5 years; nine lieutenants (N) averaged 12·2 years. This is anything but encouraging to the specialist in navigation, but in view of the immense importance of securing the best men to navigate our fleets and handle them in action, it is much to be hoped that in future lieutenants (N) will not be so heavily weighted on their way to the higher ranks of the service. It is, however, only just to add that the theory and practice of navigation under recent legislation have been placed in a position in the front of scientific education they never occupied before. N. G. T.

Purple Flowers.

IT is generally thought that purple flowers are due to selection by bees, and the small number of blue and purple flowers in New Zealand is accounted for by the supposed

absence of bees. This, however, is hardly correct, for there are several species of native bees in New Zealand which constantly visit composite flowers. But *Pleurophyllum speciosum* has very conspicuous purple flowers, although it is found only in Campbell and Auckland Islands, where there are no bees or flower-visiting moths. Nor does it stand alone, for *Celmisia vernicosa*, and its ally *C. chapmani*, are the only species of the genus with purple discs, and yet they also are only found in Campbell and Auckland Islands. In *C. vernicosa*, also, the leaves have become rigid, although no animal feeds upon it.

I think that these facts are of sufficient interest to bring to the notice of botanists, at a time when, perhaps, we too readily accept selection as the explanation of every character. For in these Antarctic islands the conditions of life are so simple that we can eliminate many causes which complicate the same problems in areas with more varied life.

F. W. HUTTON.

Christchurch, New Zealand, May 23.

The Origin of Variation.

THE following argument may be of interest to your readers, if, as I suspect, it has never been thus formulated before.

In order to account for the origin of species, we must assume that the tendency of an individual to vary is handed down to future generations by appropriate modifications in the transmitted germ-plasm. But, unless we believe in the inheritance of acquired characters (for which we have no certain evidence), the tendency of the first individual to vary can only have become manifest if it had originated in a modification of its own parents' germ-plasm; otherwise that tendency could not have been inherited. Leaving out of account the play of changing external conditions, we are thus forced to regard the variability of individuals as the result of variations in the parental germ-plasm. The problem is, how are such variations produced?

CHARLES S. MYERS.

Gonville and Caius College, Cambridge, June 29.

THE BRITISH ASSOCIATION.

THE Southport meeting of the British Association will begin on Wednesday, September 9. The local arrangements, which have been in the hands of a large and representative committee for many months past, are now well advanced, and give every indication that the meeting will not fall short of that held in Southport twenty years ago.

It was not without fear and misgiving on the part of some of its more prominent members that the Association visited Southport in 1883, but the success of the meeting in the northern watering-place was so conspicuous that at the final general meeting there was a unanimous expression of opinion that the Southport meeting of 1883 had been one of the most successful ever held, and a desire to repeat it at some future date. The meeting then stood sixth in point of numbers, and third in receipts. Since that date the Southport meeting has only been exceeded in numbers by the meetings in the neighbouring cities of Manchester and Liverpool, and in receipts by Manchester alone. 2714 people attended the meeting of 1883, and it is confidently hoped that this number will be exceeded in 1903.

The Corporation of Southport is working with the local committee to make the meeting a success, and has placed at its disposal the handsome suite of Municipal Buildings for use during the week of the Association's visit. These buildings include the Town Hall, Cambridge Hall, Art Gallery, and Victoria Science and Art Schools. The three first named of these were in use at the former Southport meeting of the British Association, but they were then without direct communication one with another. They are now connected by corridor bridges, and form an admirable suite of rooms for municipal and other social functions. The Victoria Science and Art Schools occupy a site behind the Cambridge Hall, with which, as well as with the Art Gallery, they are connected on the first floor, thus forming a further addition to the suite of reception rooms. This block of Municipal Buildings, which stands directly in the centre of the town, facing Lord Street, will be the headquarters of the Association. The reception room will be situated in the Examination Hall of the Science and Art Schools, the entrance being by the main doorway of Cambridge Hall. It is proposed that the Examination Hall shall be used for counter business only, the large room of the Art Gallery close by being used as a second reception room for conversational and general purposes. Two other of the picture galleries will be set apart for reading and writing rooms, whilst a fourth will be allotted to the representatives of the Press.

Three of the sections will meet in the Science and Art Schools, viz. Sections A (which is in two departments, Mathematics and Astronomy), B (Chemistry), and G (Engineering). Section L (Education) will meet in the Cambridge Hall, and Section H (Anthropology) in the Town Hall. Five out of the ten sections meeting this year will thus be located in the Municipal Buildings, and in easy communication one with another.

The council of the Association will meet in the council chamber of the Town Hall, and here also the general committee and the council of recommendations will hold their meetings. Two of the Corporation committee rooms in the Town Hall have been set aside for the deliberations of the International Meteorological Committee, which is meeting in Southport at the same time as the British Association, and of which a notice has already appeared in NATURE (May 14).

The laboratory of the Science and Art Schools will be used as a meteorological museum, and for the reception of apparatus and specimens illustrative of papers communicated to the sections.

The remaining five sections are all located in buildings within three minutes' walk of the reception room. Sections D and E (Zoology and Geography) will meet in the Temperance Institute, London Street, Section C (Geology) in Hoghton Street Church schoolroom, Section K (Botany) in Chapel Street Church schoolroom, and Section F (Economics), in the Y.M.C.A. building, Eastbank Street. The conference of delegates of corresponding societies will have two rooms placed at its disposal in Chapel Street Schools. All these buildings lie close to one another, and are easily reached by trams from all parts of the town.

The first general meeting of the Association will be held on Wednesday evening, September 9, at 8.30, in the Opera House, when the president, Sir Norman Lockyer, will deliver his inaugural address.

The Friday evening discourse will be delivered by Dr. Robert Munro, on "Man as Artist and Sportsman in the Palæolithic Period." On Monday evening a discourse will be given by Dr. Arthur Rowe on "The Old Chalk Sea, and some of its Teachings." The Saturday evening lecture to working men will be given by Dr. J. S. Flett, his subject being the recent volcanic eruptions in the West Indies. All these three lectures will be delivered in the Cambridge Hall, which seats about 1500 persons.

On Thursday evening the Mayor of Southport (Mr. T. T. L. Scarisbrick) will give a reception in the Municipal Buildings, and the local committee will give a conversazione in the same place on September 15.

The Mayor will further give a garden party in Hesketh Park on Friday afternoon, and Sir George Pilkington gives a garden party to a limited number of members at his residence, Belle Vue, on the afternoon of Monday or Tuesday, September 14 or 15.

The sections will not meet on Saturday, September 12, that day being set apart for excursions. Six whole-day and two half-day excursions have been arranged, and provision has been made in all for about a thousand persons. The excursions will be to (1) Manchester, visiting the works of the British Westinghouse Electrical and Manufacturing Company at Old Trafford. Opportunity will also be given of inspecting the new Technical School, the John Rylands Library, and the Chetham Hospital; (2) Stonyhurst College and Whalley; (3) Ribchester and Hoghton Tower; (4) Windermere; (5) Chester; (6) The Wirral Peninsula. Specially prepared pamphlets will be issued as guides to the excursions. The Westinghouse Co. has kindly promised to entertain the Manchester party to luncheon, and similar hospitality has been offered by the authorities at Stonyhurst College and by the Chester Society of Natural Science, Literature, and Art at Chester. The afternoon excursions on Saturday comprise drives to Hoole (the scene of the labours of Jeremiah Horrocks, the astronomer), Rufford Old Hall, and the ancient churches of Ormskirk and Halsall.

On the concluding day of the meeting, Wednesday, September 16, the following unofficial excursions have been arranged for the afternoon:—(1) Port Sunlight, Cheshire, Messrs. Lever's model village and soap works; (2) the Diamond Match Works at Seaforth, Liverpool; (3) the Cunard s.s. *Lucania* at Liverpool. On the Thursday following the meeting, opportunity will be afforded of visiting the Prescot Watch Works (a revived Lancashire industry), the British Insulated Wire Co.'s works at Prescot, the Lancashire and Yorkshire Railway Co.'s works at Horwich, and two collieries at Wigan. It has also been arranged for a steamer to run to Llandudno on this day.

Southport has made rapid advances in every direction during the last twenty years. Since 1883 much of the town has been rebuilt, the promenade has been widened, the marine parks and lake constructed, and many other important works of improvement have been effected. The Municipality of Southport is in the forefront of local government, and to its enterprise is in a large measure due the remarkable development of the town in recent years. Lord Street, the principal thoroughfare of the town, is a magnificent boulevard a mile long and more than eighty yards wide, with broad footways bordered by trees, suggesting comparison with the streets of continental rather than with those of English cities. The Municipal Gardens in Lord Street, in front of the Town Hall and Cambridge Hall, have become since last year, especially for visitors, the centre of life and movement in the town. Here the Corporation Military Band plays two or three times daily, and at night the trees are lit up with thousands of electric lights, the effect being striking and unique.

A handbook, or guide to the district, is being prepared, a copy of which will be presented to each member attending the meeting. The book will be illustrated and will contain specially prepared maps illustrating the topography and geology of the district. The district, roughly speaking, is that portion of south-west Lancashire lying between the rivers Ribble and Mersey.

The following subjects will be dealt with in the handbook:—"Sketch of the History of Southport"; "Meteorology," by Mr. Joseph Baxendell, Borough Meteorologist; "Health," by Dr. J. J. Weaver, Medical Officer of Health; "Geology and Physical Features of the District," by Mr. E. Dickson and Mr. H. Brodrick; "Botany," by Mr. Henry Ball and Mr. W. H. Stansfield; "Marine Zoology," by Prof. W. A. Herdman, F.R.S., and Mr. Isaac C. Thompson; "Coleoptera," by Dr. G. W. Chaster and Mr. E. Burgess Sopp; "Mollusca," by Dr. G. W. Chaster; "Mosses," by Dr. J. A. Wheldon; and "Antiquities," by Mr. W. Brunt. Mr. G. Napier Clark is contributing a chapter on Jeremiah Horrocks, the astronomer, and his connection with the district. The scientific portion of the handbook is being prepared under the direction of the Southport Society of Natural Science, and the general editors are Dr. G. W. Chaster, Mr. Geo. E. Johnson, and Mr. F. H. Cheetham.

In connection with the meeting and with the excursions, the following notes on the Southport district will be of interest. For the paragraph dealing with geology I am indebted to Mr. Harold Brodrick, for those on botany to Mr. Henry Ball, and for those on zoology to Mr. Isaac C. Thompson.

Geology.—The geology of the Southport district has for the most part to do with the Glacial and post-Glacial deposits. Of the older formations only comparatively small areas are exposed, having been entirely covered by Glacial deposits which have only in few places been denuded to the underlying strata. In the neighbourhood of Parbold, some ten miles inland, is a good exposure of Millstone Grit, while the Coal-measures may be well seen about Wigan, the Wigan coalfields being some of the most productive in England. Two small sections of the Permian rocks, with a thin stratum of a true magnesian limestone, may be examined in the beds of two small streams near Parbold. These beds have been proved to be fossiliferous, but only slightly so, not more than a dozen fossils in all having been found in them. Underlying the Boulder-clay, within eight miles of the coast and exposed in several places, are considerable deposits of the Keuper and Bunter divisions of the Trias.

In probably no part of England can that combination of clay, sand and gravel known as the Glacial Drift be better studied than in this district. Overlying the older formations, in some cases to a depth of more than one hundred feet, the Boulder-clay has suffered both denudation and erosion. By the latter action a range of prehistoric sand-dunes has been formed several miles inland of the present coast. These dunes offer several exceedingly interesting problems, and papers will be read before the Geological Section on this subject. Further inland, near Tarleton, are several large deposits of Glacial sand and gravel containing a considerable number of shells of an arctic type.

The Boulder-clay itself is of great interest, containing, as it does, boulders of Silurian Grits and Carboniferous Limestone from north Lancashire, Eskdale and Buttermere granites, and also several local granites and grits from the south-west of Scotland. These clays also contain a large number of Foraminifera, mostly of an arctic type.

A very large area is covered by peat mosses which have formed in the beds of old lakes and also covered the surrounding districts. These peat mosses in places are twenty feet in depth, and in them many canoes hollowed out of single tree trunks have been found. One of these, 17 feet long, will be on view during the visit of the Association.

The coast is fringed with a line of sand-dunes for a distance of some fifteen miles, while the whole of Southport is built on ground formerly covered with dunes, which have been levelled; in some places, as near Formby, six miles south of Southport, these dunes are more than three miles in width and rise to a height of more than 80 feet. The sand of the dunes is composed of materials eroded from the Triassic sandstones and then cast on to the shore by the sea, from where it is blown into dunes by the prevailing westerly winds. A considerable area in the estuary of the Ribble to the north of Southport is covered by a salt marsh formed by the deposition of silt at the meeting of the waters of

the Ribble with those of the sea. This district is of considerable interest, as in it may be studied the question of the formation of estuarian clays and their attendant flora and fauna.

On the whole, although at first sight the district does not seem to offer many opportunities of study to the geologist, yet on further consideration many problems and objects of great interest are to be found.

Botany.—Turning to the flora of the district, we find that, in spite of the apparent bareness of the long stretch of sand-dunes, they are by no means barren from a collector's point of view. In addition to the usual littoral flora, which is even here thoroughly representative in variety, nature, and outline, the diligent seeker will be rewarded by many choice finds. We must be pardoned for placing as an easy first, in regard to beauty as well as variety, the seaside form of the round-leaved winter-green, *Pyrola rotundifolia*, Linn., var. *maritima*, Kenyon. This plant is here abundant, and when in full bloom is an object of great loveliness. Here also, nearer to the sea line, may easily be found quite a family group of the centaurys (locally termed sanctuary). Every species now recorded in the London catalogue, save one, has been gathered on this coast. The rarest of them, however, the broad-leaved centaury, *Erythraea latifolia*, though originally found here, seems to be now extinct. Accompanying these plants there occurs, sometimes in patches like small fields, another member of the same natural order (Gentianeæ), the yellow-wort, *Blackstonia perfoliata*, Hudson, whilst in similar patches, and even more luxuriantly, there grows the Grass of Parnassus, *Parnassia palustris*, Linn. In higher and drier situations, too, the searcher is rewarded by the discovery, in fairly large quantities, of two beautiful euphorbias, both comparatively rare elsewhere, namely, *Euphorbia Paralias*, Linn., and *E. Portlandica*, Linn. The latter is a lovely object in the autumn, its green foliage changing to a bright crimson as the plant gradually fades.

The aquatic plants of the district are well worthy serious study, and include a very interesting group of drop-worts (Œnanthe), marestail, *Hippuris vulgaris*, Linn., and a few miles inland whole dykes covered over with the beautiful water-violet, *Hottonia palustris*, Linn. To refer once more to the sand-dunes, the collector may be interested to know that here grows that wonderful botanical enigma, the yellow bird's nest, *Hypopitys Monotropa*, Crantz, and a capital variety of orchids, including *Epipactis palustris*, Crantz. On the whole, to anyone in search of British wild flowers, the district is rich and repaying.

Zoology.—With the exception of its marine fauna, which is very rich, and is to be specially dealt with in the handbook now in preparation, Southport cannot be said to possess any very distinctive zoological features. No quadrupeds are peculiar to the district. But in early times, probably succeeding the last Glacial epoch, when the flat country around Southport was more elevated than now, it is evident that the Irish elk, *Cervus megaceros*, roamed here in abundance, many skulls and other remains of this animal having been found embedded in the clay beds of a large inland lake no longer existing, known as Martin Mere. It is suggested by Mr. G. W. Lamplugh, in his recent geological survey of the Isle of Man, that the Irish elk migrated across the waning ice-sheet which lingered in the Irish Sea at the close of the Glacial period.

In ornithology Southport bears a good record, and though the number must have been decreased of late years, no less than 130 species of birds were known to the district half a century ago. Among the birds that now visit the neighbourhood during spring and summer are the swallow, stone-chat, white-throat, yellow wagtail, northern diver, snow bunting, black and little tern, and wheatear, for many of which the numerous sandhills offer congenial attractions. In winter the bodies of storm-tossed birds, as the puffin, razor-bill, and stormy petrel, are often cast upon the shore, or become entangled in the fishermen's nets.

Numerous lizards haunt the sandhills, where also the conchologist will reap a good harvest not only in land mollusca, which are very abundant, but in marine species, including some of which no representatives are now found on the shore, and which were, doubtless, deposited at a distant era when the sea covered much of the present land. Cockles and shrimps are yet taken at Southport in great abundance. To the entomologist the sandhills of Southport afford a valuable hunting ground, as will be seen from the number of species and genera recorded in the forthcoming handbook.

Archaeology.—The district of Southport is not so destitute of interest to the antiquarian as might at first be supposed. Southport itself can boast no history prior to the end of the eighteenth century, but Birkdale and Churchtown, at the two extremes of the borough, can both claim a respectable antiquity. Roman coins are said to have been found on Birkdale Common.

This part of Lancashire is the "Inter Ripam et Mersham" of the Domesday Survey, but the antiquarian interest goes back to Roman times, when there were Roman stations on both the Mersey and Ribble, a Roman road leading from what is now Warrington through Wigan to Ribchester. The country west of the line of this road was, until comparatively recent times, very isolated, and consisted largely of low, swampy ground interspersed with woods and growing timber. The Roman station at Ribchester will receive the attention of the members of the British Association on one of the Saturday excursions, when Mr. John Garstang, of University College, Liverpool, and author of "Roman Ribchester," will explain the history of the Roman occupation on the site. Mr. Garstang will also read a paper on Roman Ribchester before Section H.

Close to Southport is the site of Martin Mere, once a large shallow fresh-water lake. It is now drained and used as agricultural land. Mention has already been made of a large canoe dug up here, and it is hoped that other antiquities (bronzes, &c.) obtained from the site of the lake may be on exhibition at the time of the meeting. Martin Mere is one of the many places which claim connection with the Arthurian legend. The river Douglas, the whole course of which lies within this district, is reported to be the scene of some of King Arthur's most bloody battles! Claims are also put forward by both the Ribble and Mersey, north and south of Southport, as the site of Athelstane's great victory of Brunanburg.

Lancashire is rich in old halls, and many of these are within easy reach of Southport. Visits will be paid to Rufford Old Hall, which contains a very fine example of a great hall of the fifteenth century, and to Hoghton Tower, an interesting and finely situated Elizabethan mansion, recently restored, the residence of Sir James de Hoghton, Bart. Hoghton Tower disputes with Pimp Hall, Essex, the title of being the house in which King James I. knighted the loin of beef. Of the lesser halls in the immediate vicinity of Southport, mention may be made of Lydiate, Hurleston, Mawdesley, and Heskin. Larger houses, like Speke and Smithells, lie further afield, and can only be visited by special permission.

In ancient ecclesiastical architecture Lancashire cannot be said to be well off. There is an ancient Norman chapel at Stydd, near Ribchester, an opportunity of visiting which will be given, but otherwise nearly all the churches of Lancashire belong to the late Per-

pendicular period. Halsall, however, four miles from Southport, possesses a fine parish church, largely of fifteenth century date, which will be visited, and the church at Ormskirk is unique in England in possessing a western tower and spire standing side by side. Sefton church is a late sixteenth century building, with remains of earlier work in parts, and has some good interior woodwork. At Burscough, eight miles distant, are the remains of an Augustinian priory, which in its day was one of the most considerable religious houses in Lancashire.

Carr House, at Hoole, a brick building erected in 1613, is reputed to be the house in which Jeremiah Horrocks observed the transit of Venus in 1639, and Hoole Church, though without architectural merit of any kind, is interesting as the chapel at which Horrocks officiated. There are the remains of a large number of wayside crosses in this part of Lancashire, an excellent specimen standing in Scarisbrick Park, about four miles from Southport.

Lathom is the scene of the famous siege of Lathom House by the Parliamentary forces in 1644, where Charlotte de la Tremouille, Countess of Derby, made her famous defence. She is buried along with the Earl in the neighbouring church of Ormskirk. Old Lathom House has given place to a classic mansion erected in 1724–34 from the designs of Leoni. Scarisbrick Hall is another old Lancashire mansion that has been rebuilt, the modern house, designed by Augustus Welby Pugin, being a fine example of the domestic work of the Gothic revival.

All along the coast of Lancashire are evidences of submerged lands, and the interest of the Leasowe coast of the Wirral Peninsula is well known to all those who have inquired into the subject of the alteration in the coast line of the country since Roman, or even Norman, times. An opportunity will be afforded of inspecting the submerged forest at Leasowe, and another submerged forest is to be seen nearer to Southport, at the mouth of the Alt, near Formby.

Of places not falling within the Southport district, but which will be visited by the Association, the antiquarian interest of Chester is too well known to need comment. At Whalley are the remains of a great Cistercian abbey, and Whalley church is a building full of architectural and antiquarian interest from the thirteenth to the sixteenth centuries. It contains the stalls belonging to the abbey church, which has completely disappeared. In the churchyard are three pre-Norman crosses. Time may allow also of a visit to Mytton church and Little Mytton Hall, which lie between Whalley and Stonyhurst. Stonyhurst itself has some antiquarian interest, the original building being a fine Elizabethan house, now incorporated in the vast college buildings. At Manchester mention must be made of the fifteenth century Chetham Hospital and Library, adjoining the Cathedral.

The archæology of the immediate district of Southport may be described as of local rather than of general interest, but a reference to the volumes of proceedings of the Historic Society of Lancashire and Cheshire, and of the Lancashire and Cheshire Antiquarian Society, which will be found in the Southport Reference Library, will show that antiquarian research is very active in the two counties.

The railway companies will issue return tickets to Southport from the principal stations in the United Kingdom at a fare and a quarter on surrender of the usual voucher issued to members. The tickets will be available from September 8 to September 18 inclusive. The local railway companies will issue return tickets at a fare and a quarter to members during the meeting for short distance journeys. F. H. CHEETHAM.

NEW SERUM DEPARTMENT OF THE JENNER INSTITUTE.

UPON the invitation of Lord Lister and the governing body of the Jenner Institute of Preventive Medicine, a number of distinguished guests inspected, on Friday last, the new laboratories and stables which the institute has recently acquired at Queensberry Lodge, Elstree, Herts.

The removal from the former site at Sudbury, near Harrow, became necessary from the encroachment of the Great Central Railway, and the authorities of the institute were fortunate in acquiring a site which is eminently suitable for carrying on the work of the department. This work consists largely in the preparation and testing of antitoxins, such as diphtheria antitoxin, tetanus antitoxin, and antistreptococcic serum, and in carrying on research work in connection with these, and on questions of immunity.

Certain researches also in comparative pathology can be suitably conducted only under such conditions as exist in a department of this character.

The buildings are on the summit of a small hill, and are surrounded by about twenty-eight acres of meadow land, which is conveniently divided into small fields suitable for pasturing and exercising the horses and other animals, such as goats and sheep, which are used in connection with the work. Queensberry Lodge itself has been retained practically as it was when the estate was acquired by the institute, and is now used for the accommodation of the junior staff, administrative offices, &c. The bacteriologist-in-charge lives in a separate house. The laboratories, which have been built by the institute from designs by Mr. Paul Waterhouse, are of the most modern type, with papyrolith floors with rounded corners, white glazed adamant walls with a dado of white tiles, and large window space. They are warmed by open fireplaces. There is a good gas and water supply, and the buildings are lit by Welsbach incandescent gas burners. The main ideas in the arrangement of the departments have been to provide separate buildings and isolated rooms for carrying out the different processes for the production and testing of antitoxins, thus avoiding risk of contamination of the serum, and at the same time affording adequate laboratory accommodation for the prosecution of research work. In this connection it has been considered advisable to have several small laboratories for one or two workers where undisturbed work can be carried on rather than large laboratories capable of accommodating a number of workers.

The laboratories comprise:—

A Large Routine Laboratory.—This room is furnished with both side and roof lights, and is fitted with centre and side benches, fume chamber, &c. It is used for general chemical work, for the filtration of diphtheria toxins, for fitting up apparatus, and for such work as section-cutting and blow-pipe work.

Two Private Research Laboratories.—These rooms are well lighted with a north-east aspect. They are completely equipped as bacteriological laboratories, have low benches for microscopical work, and separate Hearson incubators, shelves for reagents, media, &c.

The Serum Laboratory.—The windows in this room are of ruby glass so as to ensure a non-actinic light. It is used for the filtration and storing of the various sera, and contains two large ice-safes for that purpose. It is fitted with a work bench which has connections with a water-vacuum pump, and is also furnished with a Geryk pump.

The Engine Room is fitted with a gas engine driving a large Runne's centrifugal machine and a disintegrator. There is also a Root's blower, which supplies sterile air to the bottling room. There is a water-pump supplying a vacuum and high-pressure air to the neighbouring rooms.

The Incubation Room is a small insulated room, the insulation being obtained by its having double walls, the space between which is packed with asbestos. It has two doors forming a small "air-lock" to prevent the inrush of cold air on opening the door. By means of a gas-stove and Roux regulator the temperature is maintained at body-heat. This room is used for the cultivation of the different microorganisms used in connection with the work of the establishment.

The Bottling Room is reserved entirely for filling the serum into flasks. The windows are of non-actinic ruby glass, and are air-tight. Before bottling is commenced the room is filled with formalin vapour, which is allowed to remain in the closed room all night. In the morning the formalin vapour is displaced by a current of cold air from the outside of the building, which is blown into the room by the Root's blower in the engine room. This air is sterilised before its entry by passage through a large filter of sterile cotton wool. The current of sterile air is maintained throughout the process of bottling, entering the room through the filter and passing out by an exit in the roof through a cotton-wool filter.

The Culture Medium and Sterilising Room.—This room is used for the preparation and sterilising of the media employed in the cultivation of the various microorganisms. It is fitted with autoclaves, steam sterilisers, thermostats, &c. This room communicates with the cultivation room by double doors, through which the flasks can be passed after inoculation, thus avoiding lowering the temperature of the hot room by repeatedly entering it.

The Glass Cleaning Room contains a dry-heat disinfector for sterilising the glass apparatus, and is fitted specially for the purpose of cleaning and sterilising glass apparatus.

An Isolated Laboratory stands entirely apart from any other building. It is used for the preparation, filtration, and precipitation of such things as tetanus toxin, &c., and for the examination of small animals.

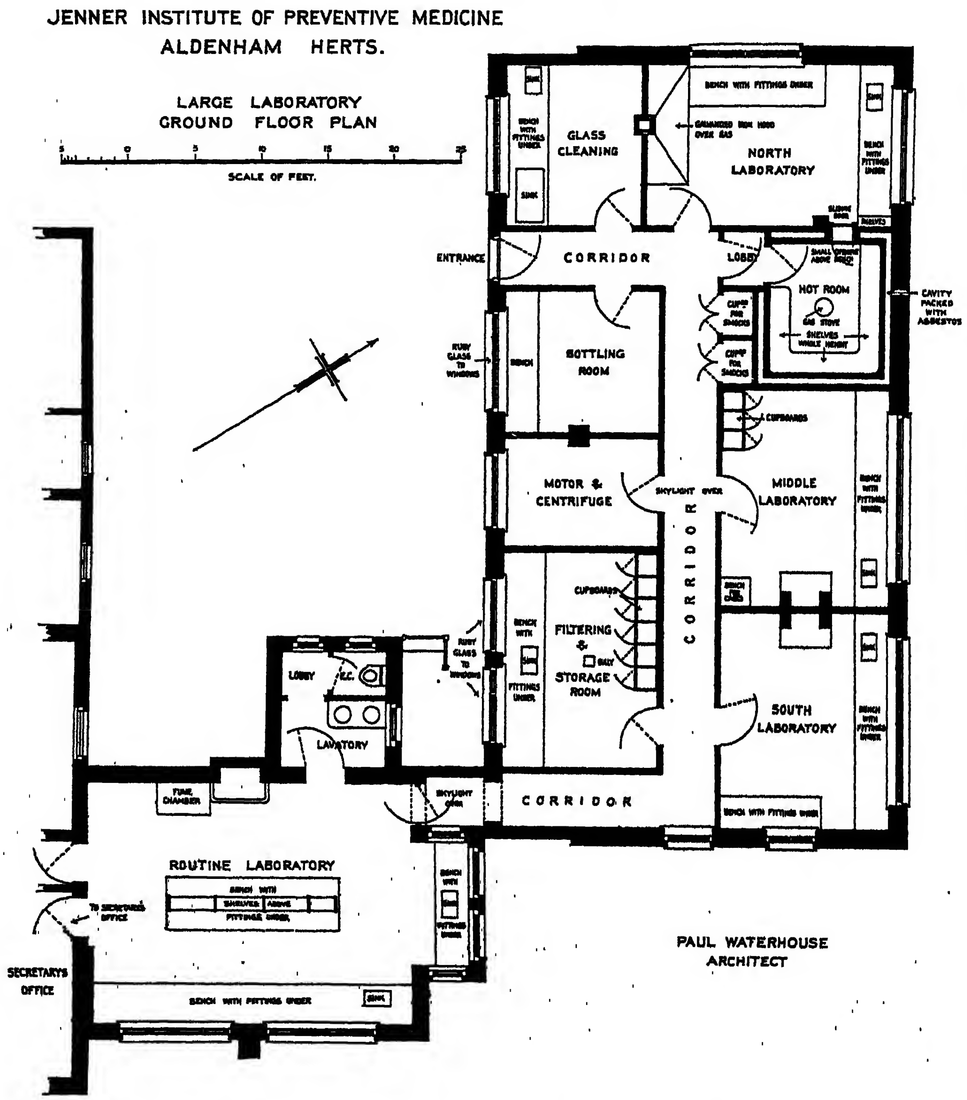


FIG. 1.—Plan of New Laboratories of the Jenner Institute at Elstree, Herts.

At a considerable distance from the main laboratories, there is a complete small department with stables for carrying on work in connection with other infectious diseases, in addition to those previously mentioned.

The Animal Houses are ordinary garden greenhouses which have been adapted and prove excellent for the purpose, as they are easily kept to an even temperature. The largest is used as an experimental animal house for the housing of animals employed in the testing of the sera, toxins, &c. The roof is covered with vines, which have been retained as affording a shelter from the sun in summer. The two smaller houses are used for breeding purposes. The three houses are heated by a system of hot water pipes.

The Principal Stables form two blocks of buildings about 200 yards from the laboratories. They are all brick, and of the most modern type. There are two yards, the first of which is covered by a high glass roof, and opening from this yard is the operating room, where the horses are injected and bled. The stabling consists entirely of loose boxes, which are very well ventilated, and are all of a large size, so that the animals have ample room to move about freely.

In the vicinity of the operating room is a small isolated room with slate benches, where the blood flasks are allowed to stand, and where the serum is decanted.

In one of the meadows, at a distance from the stables, is a loose box which is used as an isolation box. All new horses here undergo a period of quarantine. There are several other loose boxes in the various meadows, as well as an isolated cow-shed, goat-house, pigeon-house, rabbit-runs, &c.

ARCHÆOLOGICAL DISCOVERIES IN CRETE AND EGYPT.

THE undoubtedly close connection which existed between the Bronze age civilisations of Greece and Egypt is now generally recognised by archæologists. Not only was Egyptian influence on the development of the "Mycenæan" culture always very marked, especially from the period of the thirteenth Egyptian dynasty (B.C. 2000) to the end of the eighteenth (B.C. 1400), but the most recent discoveries seem to point to the unlooked-for conclusion that the two chief civilisations of the Eastern Mediterranean may have had a common origin, presumably in Africa. Certainly the further we go back the more striking are the parallels between early Egyptian and early Greek culture. It is, then, nowadays natural to group together the archæological discoveries which are being made in Egypt and in Crete, which was apparently the seat of the most fully developed phase of the Greek civilisation of the Bronze age.

During the present season (1903) Mr. A. J. Evans and Mr. Mackenzie have pursued the investigation of the great palace of Knossos in Crete, the legendary seat of the Minoan dominion over land and sea. The chief discoveries of the year are:—(1) a stepped theatre, after the fashion of that at Phaistos, but smaller and not so well preserved, lying to the west of the north gate; (2) a building, perhaps a small sanctuary, lying immediately north of the north gate, and directly in the line of its axis; (3) a house, lying a quarter of a mile to the north-east, on the slope of the hill, overlooking the stream of the Kairatos; and (4) two magnificent bronze vases, one of them closely resembling a type depicted among the offerings of the Keftian Cretans in the tomb of Rekhmara at Thebes in Egypt, *circa* 1550 B.C.

The house is remarkable, and contains a room with an apsidal end; it is, in fact, a sort of prototype of the basilica, which is now carried back to Mycenæan days!

What next year's excavations may bring forth it is impossible to guess, but there certainly seems no end to Knossos.

The Italian excavations at the small palace of Agia Triada, near Dibàki, in the Messarà, are proceeding under the direction of Prof. Halbherr and Drs. Pernier and Peribeni; the finds have been important, consisting of fragments of stone vases decorated with reliefs representing gladiatorial combats, bull-fights, and the presentation of spears to departing warriors by a king, and of a hoard of great talents of copper and bronze, measuring each more than a foot long, which are identical in type with the metal ingots brought as tribute to Egypt by the Keftians. The vases are of the same kind as that representing a harvest-home procession, found at Agia Triada last year.

The American and English excavations at Gourniă and Palaiokastro, under Miss Boyd and Mr. R. C. Bosanquet respectively, have produced interesting results, especially in the domain of pottery and small cult-objects, of which Palaiokastro and a hill-sanctuary in its vicinity have afforded numbers of interesting examples.

Apart from the discovery of the tomb of King Thothmes IV. by Mr. Carter at Thebes, and of a small portrait figure of King Khufu (Cheops), the builder of the Great Pyramid, by Prof. Petrie at Abydos, the most interesting excavations undertaken during the past season in Egypt have been those of Mr. Garstang at Beni Hasan. Below the well-known large tombs of the Twelfth Dynasty nomarchs, he has discovered a row of Sixth Dynasty sepulchres, and a great number of "pit-tombs," of the Eleventh and early Twelfth Dynasties. In some of these, notably in that of Nefer-i, a physician, has been discovered the funeral furniture intact. This, as is usually the case with burials of this period, included numbers of wooden models of the boats in which the mummies were ferried across the stream to the necropolis, and of the Nile-ships in ordinary use, with their crews, &c., notably a warship on which is a group of two men playing chess under a canopy, formed of two of the great cow-hide shields in use at the time; a similar shield-canopy is seen on a boat of the same period in the British Museum, No. 35293. Models of granaries and model groups of fellahîn engaged in their daily avocations were also found. Photographic records were taken of the various stages of the opening of all tombs, more than 450 negatives being secured. This is a most satisfactory feature of Mr. Garstang's excavations. It is also satisfactory to know that most of the finds will be placed in public museums and private collections in England. The results of the Cretan excavations have to remain in Crete, housed in a ramshackle Turkish *ex*-barrack, the floors, staircases, beams, and pillars of which are of wood, and in which smoking is freely permitted. The collections brought together there by the energy of English, American, and Italian excavators are unique, and include many classes of objects, *e.g.* the inscribed tablets from Knossos, which are unrepresented in the properly built and protected museums of Europe. It would, indeed, be deplorable if the treasures of Knossos, which have survived one conflagration—that in which the palace was destroyed—were to perish in another.

WHITE SPOT ON SATURN.

ON July 1, after observing Jupiter for some time, I directed my 10-inch reflector to Saturn, and found the details sharply defined. The dusky north polar cap was very distinct, and so was the dark belt on the north side of the equator. The belt was darkest and more strongly outlined on its southern side, probably by contrast with the bright equatorial zone. I soon noticed a large bright spot on the north side of the belt, and in a position nearing the western limb of the planet. It was followed by a diffused dusky marking. The luminous spot must have been on the planet's central meridian at about 14h. 1m., but this is only a rough estimate, as the marking was far past transit when I first saw it. It is to be hoped that this feature will prove fairly durable, in which case it may be expected to furnish an excellent means of redetermining the rotation period of Saturn.

A telegram from Kiel (mentioned in your last number) states that Barnard, of the Yerkes Observatory, saw a white spot in Saturn's N. hemisphere central on June 23, 15h. 47·8m. Williams Bay time. Allowing for the difference of longitude, this would be 21h. 42m. G.M.T. Adding eighteen rotations of Saturn of about 10h. 14m. will bring us to the time when the spot was approximately in transit as observed at Bristol, and there seems no doubt as to the identity of the objects.

This disturbance on Saturn will recall Prof. Asaph Hall's white spot seen in the winter of 1876–7, and followed from December 7 to January 2. A number of transits of this object were observed by Hall, Eastman, Newcomb, Edgecomb, and A. G. Clark, and from the data obtained the former found the rotation period of Saturn to be

10h. 14m. 23·8s. ± 2·30s. mean time.

The spot lengthened out into a bright belt, and soon lost its distinctive character.

Should the present object remain visible, it will be on or near the central meridian of Saturn on July 10, 13h., July 13, 12¾h., and July 16, 12h. 10m.

W. F. DENNING.

NOTES.

THE visit of President Loubet to England, as a guest of the British Court, is an event which should not pass unnoticed in the scientific world; he comes as the representative of the French nation. On many occasions President Loubet has shown interest in scientific meetings and congresses held in France, and has extended the warmest hospitality to the foreign members who attended them. His country takes a place in the foremost rank of those which are contributing to the advancement of science, and the names of leading French investigators are familiar words not only in the British Isles, but in all places where scientific knowledge is cultivated. It is a pity that the British associates and correspondants of the Academy of Sciences have not taken the opportunity to welcome President Loubet, as the representatives of the scientific interests of both nations. Such an act of simple courtesy ought not to have been omitted.

LORD KELVIN and Lord Lister have been elected honorary members of the Royal Society of New South Wales.

LORD LISTER has been admitted to the honorary freedom of the Merchant Taylors' Company in recognition of his "long and valuable services to the country, and particularly to surgery, by the discovery and application of the antiseptic treatment."

AT a meeting held last week in the rooms of the Royal Statistical Society, it was resolved to form a society for the promotion of scientific and philosophical studies in sociology. A committee was appointed to consider the question of the scope and aims of the society, and to draft a constitution to be submitted to a meeting in the autumn.

A PARIS correspondent writes:—On July 3 the *Temps* resolved to send a message round the world by telegraphy, using the Anglo-French system of transoceanic cables. The message was sent from Paris at 11 a.m., and consisted of the two words *Temps*, Paris, with the indication of the route, *viâ* Malta, Aden, Singapore, Brisbane, Vancouver, and French Atlantic Cable. As the indication of the route is not paid for, the cost of the experiment was only 13*s.* 1½*d.* No previous explanation or preliminary notice had been served to the several companies, but the organisation of the Anglo-French system is so perfect that the message arrived at the *Temps* office at 5.30 p.m. The time spent had been six hours for travelling about 40,000 miles, a measure of the commercial speed of electricity on the occasion of the inauguration of the American, Sandwich, Philippine, and Hong Kong system.

THE automobile races in Ireland last week give remarkable evidence of the power and perfection of modern motors. The race for the Gordon Bennett Cup, over a course of 370¾ miles, was won by a German car, driven by a Belgian, M. Jenatzy. The net time spent in covering this distance was 6h. 39m., which gives an average of nearly 56 miles per hour on ordinary roads. The second place was taken by a French car, the time being 6h. 50m. 40s. Three other competitors finished the race, two of them driving French cars, while the fifth place was taken by an English car. Some extraordinary speeds were attained by automobiles over a course in Phœnix Park, Dublin, on Saturday. For racing purposes the programme was divided into three sections, one for motor cycles, one for touring cars, and one for racing cars. The fastest motor cycle travelled at the rate of 48.2 miles an hour, and the fastest touring car at 46.5 miles an hour. In the racing section a Décauville light racer covered the course in 1m. 53 1-5s., at the rate of 62½ miles an hour; a 60-h.p. Mercédès at the rate of 78 miles an hour; a 70-h.p. Mors at the rate of 83 miles an hour, and also at 85.9 miles an hour.

REUTER'S Agency is informed that Commander Irizar, the Argentine naval officer who will command the relief expedition which is being sent out by the Argentine Government in search of Dr. Otto Nordenskjöld's South Polar Expedition, will leave for Buenos Ayres in a few weeks. The ship—the *Uruguay*—will be in charge of Argentine officers and crew, and will be provisioned for two years. It is not, however, probable that she will winter in the Antarctic.

THE eighty-sixth annual meeting of the Société helvétique des Sciences naturelles will be held at Locarno on September 2–5. At the same time and place the annual meetings will be held of the Swiss societies of geology, botany, zoology, and chemistry, and the Zurich Physical Society. In addition to the general and special meetings, there will be several receptions, banquets, and excursions to places of interest. The officers of the annual committee are M. A. Pioda, president, Prof. G. Mariani, vice-president, Dr. R. Natoli and M. C. Orelli, secretaries.

AN expedition recently left Baltimore for the purpose of making an exhaustive study of the Bahama Islands, and presenting reports upon them to the United States Government. We learn from the *Scientific American* that the expedition originated with Prof. George B. Shattuck, of the Johns Hopkins University, and is under the auspices of the Geographical Society of Baltimore, which defrays a portion of its expenses. Some of the principal lines of investigation will be concerned with the animal and plant life of the islands. The geology of the group will also be examined, and a bench mark will be left with the view of ascertaining to what extent, if any, the Bahamas are sinking or rising above sea level. The industries will be made the subject of a special chapter of the reports, as well as the physical condition of the inhabitants, the extent of the commerce of the principal towns, and any other economic features which may suggest themselves. An elaborate outfit of scientific apparatus for studying the meteorology and climatic conditions, for microscopic examination, and for photographic work has been provided. The diseases which may be prevalent and general sanitary conditions will be included in the investigation. This portion of the work will be in charge of Dr. Clement A. Penrose, of Baltimore, assistant director of the expedition.

IN NATURE of April 30 (vol. lxvii. p. 601) Prof. J. J. Thomson put forward the view that the energy of the Becquerel radiation given out by radio-active substances is produced by a change in the configuration of the atom. Dr. J. Stark writes from Göttingen to state that this view was suggested by him in his book "Die Elektrizität in Gasen" (Leipzig, 1902, p. 34), and later in the *Naturwissenschaftliche Rundschau* (January, 1903). Dr. Stark adds:—"As the transformation of atoms in some elements is still going on, it may be supposed that there was a time when our chemical atoms did not exist in the present amount, while other types of matter were more common. In the later change of the arrangement of the positive and negative electrons, or in the genesis of the present chemical atoms, a very large amount of the potential energy of their electrons was transformed to kinetic energy. The energy liberated in the change of chemical atoms is of a higher order of magnitude than that produced in known chemical reactions. Therefore it is reasonable to suppose that the temperature of the sun and stars is partly due to the genesis of chemical atoms."

THE prospect of active work in connection with the ship canal across the Isthmus of Panama has directed attention to the climate of the district, in which engineering work of exceptional difficulty will have to be undertaken. The results are generally reassuring, and with ordinary care a repetition of the horrors that accompanied the construction of the Panama railway need not be feared. The most noticeable feature in the temperature factor is its constancy throughout the year, the monthly range, in the mean, being confined between $78^{\circ}\cdot4$ and $80^{\circ}\cdot1$. The daily range on the coast is from 68° to 87°, and in the interior from 64° to 94°. It is easy to see the effect of the oceans in thus limiting the range of temperature, but necessarily there is an increase in the humidity, which is always high, throughout the year. There is a great difference in the rainfall on the Pacific and on the Atlantic coasts; about 140 inches may be anticipated on the former, while only half that amount will fall on the Atlantic side. From January to April the fall is very slight throughout the Isthmus, and therefore several successive months of dry weather can be counted upon, which cannot but be of great advantage in the engineering operations. Winds are always light, and give no trouble. Greater velocities than twenty miles an hour are rarely met with. The general health statistics are not unfavourable. Recent inquiries show that the mortality due to diseases of the climate has steadily diminished since 1881, while the percentage of deaths arising from European diseases has not increased. Of the total death rate, 91 per cent. is due to chronic organic diseases common to all countries, and only 9 per cent. is chargeable to local effects. This material improvement is due, in some measure, to the fact that the excavations have reached a level below the poisonous emanations of decaying organic matter, while, on the other hand, greater sanitary precautions have reduced the effects of the most deadly of the infectious diseases, yellow fever. Colon has been practically free from this scourge for some time, but improvements in Panama are loudly demanded.

IN the *Rendiconto* of the Naples Academy for April, Prof. Ernesto Pascal gives the integration of a differential equation of Riccati's form, but of a more general character than those previously considered. The right-hand side of Prof. Pascal's equation contains three constant coefficients, and the equations integrated by Malmstén, Brioschi, and Siacci are the particular cases deduced by putting one or other of these coefficients equal to zero.

VOL. v., No. 1, of the series of monograph supplements of the *Psychological Review* is a thesis by Dr. Joseph W. L. Jones on "Sociality and Sympathy." The author traces the development of consciousness to the point at which "consciousness of kind" emerges, and discusses the gradual evolution of social relationships and the rise of sympathy in any given race.

DR. COSTANTINO GORINI discusses in the Lombardy *Rendiconti* the remarkable power exhibited by the typhus bacillus of spreading along the surfaces of solids in contact with the nutrient liquid. This effect the author considers is due to the formation of filaments rather than to the mobility of the bacteria themselves, but it suggests the danger which may arise from watering food-plants with water containing the bacteria.

A REPORT on the dilatation of steel at high temperatures is given by MM. G. Charpy and L. Grenet in the *Bulletin de la Société d'Encouragement* for May. The most noticeable features brought out in the experiments were the sudden contraction at a temperature of about 700° common to carbon steels, the existence of a second point of contraction at about 300° in tempered steel containing 0·65 to 1 per cent. of carbon, and of a further point of contraction near 150° for tempered steels with more than 1 per cent. of carbon, and the absence of any observed relation between the dilatation-curves of nickel steel and their magnetic properties.

THE eleventh volume of the *Atti* of the Naples Academy of Physical and Mathematical Sciences contains a monograph by G. de Lorenzo and Carlo Riva on the crater of the Astroni, one of the most remarkable craters in the Phlegrean fields. It derives a melancholy interest from the fact that, before its completion, Signor Riva met with his death in the prime of life while ascending Monte Grigna from the Lake of Como. Another noteworthy feature is the monograph of 220 pages on the totality of prime numbers up to a given limit, by G. Torelli.

UNDER the title of "Bathymeter," Mr. Leonard Murphy describes in the *Economic Proceedings* of the Royal Dublin Society a simple apparatus for gauging the depth of liquids in wells and tanks. An air tube dips into the liquid to be measured, and an air compressor is connected both with this tube and with a reservoir of liquid into which there dips a gauge glass. On working the compressor the liquid in the gauge glass rises until the pressure is sufficient to force the air out at the bottom of the air tube, and the height of liquid in the gauge glass then indicates the height of liquid in the well above the end of the tube.

IN the *Annali di matematica pura ed applicata*, Signor T. Levi-Civita deals with singular solutions in the problem of three bodies or particles which attract each other according to the Newtonian law. The only case in which singular solutions occur is when, at some instant of the motion, two of the particles coincide; this involves an impact between the particles. The motion in which the particles are approaching impact is called by the author a trajectory of collision, the reversed motion being a trajectory of ejection. The case discussed is that in which the bodies are moving in one plane, and the mass of one is negligible compared with those of the other two.

FROM the *Economic Journal* we take the following table of the ages of German university professors in the year 1901, quoted from an article by Dr. F. Eulenburg in the *Jahrbücher für Nationaloekonomie*:—

Age	30	35	40	45	50	55
Number ... 2	23	124	206	256	262	
Age	60	65	70	75	80	85
Number ... 197	194	108	36	18	3	

where the upper figures represent ages, and the lower figures represent numbers of German professors in 1901 in the intervals between those ages. In 1890 the maximum number was between the ages of forty-six and fifty.

IN *Cosmos*, M. Lucien Fournier discusses the phenomenon recently described as the "flow of marble," which results in a gradual bending or deformation of marble blocks, as was described by Dr. T. J. J. See in a letter to NATURE of November 20, 1902 (vol. lxvii. p. 56). Among the theories proposed to account for the effect, the actions of sunshine and moisture have hitherto received support. M. Fournier now suggests another possible cause—elasticity. It is observed that blocks of granite frequently expand when they have been relieved from the pressure of the surrounding rocks in the process of quarrying. It is now suggested that a similar cause may account for the bending of the blocks of marble, and this explanation would account for deflections which assume a different direction from that which would be expected if heat and damp were the causes.

THE *Journal de Physique* contains two short papers by M. R. Blondlot on a new kind of light obtained originally after filtering the rays from a focus tube through aluminium or black paper. In studying the action of the radiations on an electric spark, they were shown to present the phenomena of rectilinear polarisation, and it was further found that both quartz and sugar produced rotatory effects. On passing the rays through a plate of mica, double refraction took place; finally, the existence of refraction was proved by concentrating the rays with a lens, and reflection was also observed. It followed that the radiations were entirely different from Röntgen rays, and must be attributable to a new kind of light. In the second paper in the July number, M. Blondlot finds that radiations possessing identical properties are obtained from an Auer lamp, and that the new rays will pass through certain metals and substances which are opaque to the radiations discovered by Prof. Rubens.

IN the *Proceedings* of the Royal Society for March, Mr. H. M. Macdonald, F.R.S., gave an investigation of the bending of electric waves round a spherical obstacle, which was suitable to explain Mr. Marconi's successes in employing wireless telegraphy over distances representing considerable arcs of the earth's circumference. Mr. Macdonald's solution has been called in question in papers communicated to the Royal Society by Lord Rayleigh and M. Poincaré. It is pointed out that Mr. Macdonald's conclusion as to the diffraction taking place without the production of any sensible shadow does not agree with the results known in the case of light; indeed, if the conclusion were accepted without any limitations, there would necessarily be daylight all night. From a mathematical point of view the results depend on the assumption that the spherical functions entering into the expression for the potential satisfy a condition of the form $dW/dr = ikW$; this is true in the case of spherical functions of low order, but unless the series for the potential is uniformly convergent, the solution may involve spherical functions of high order, for which the condition in question does not hold good.

WE have received from Prof. B. Sresnevsky a pamphlet containing synoptic tables of the daily rainfall values at all the meteorological stations of the Russian Baltic provinces for the year 1900.

THE *Transactions* of the South African Philosophical Society for April last contains a lengthy contribution by Mr. J. R. Sutton, superintendent of the De Beers meteorological station at Kenilworth, Kimberley, on the results of some experiments upon the rate of evaporation. For, as the author points out, of the dozens of patterns of evaporators, not one has hitherto been unreservedly accepted as a standard, and the results obtained from some of them show a rate of evaporation fully twice as great as others. The greatest mean annual result of seven years' observations by the author gives an evaporation of 90·11 inches, and was obtained from a copper pan about 5 inches deep and 8 inches in diameter, kept nearly full of water, and protected from the sun's rays. The monthly means varied from about 3 inches in June to nearly 12 inches in each of the months November and December. For the year 1900, the comparative annual values given by four evaporators are:—8-inch copper pan, 90·82 inches; a screened iron tub, enamelled white inside and out, 14 inches in diameter and 20 inches high, 61·98 inches; circular steel tank, nearly 4 feet in diameter and 30 inches deep, 55·21 inches; a Piche evaporating tube of the usual pattern, 82·83 inches. The author finds (1) that the most potent agency regulating the rate of evaporation was the humidity of the air; (2) that a wind factor is suggested; and (3) that the great perturbing influence attributed to the temperature of the water has not been exactly confirmed. The paper will well repay a careful study.

EVIDENCE of a connection between the occurrence of thunderstorms and the moon's age has been referred to in NATURE on several occasions. Prof. W. H. Pickering gives a table in *Popular Astronomy* to show the results of investigations of this relationship by various observers. From this table, which is abridged below, it will be seen that, with one exception, the number of thunderstorms occurring near the first two phases of the moon is greater than the number occurring near the last two.

The Moon's Phases and Thunderstorms.

Station.	Authority.	Years.	New and First Quarter.	Full and Last Quarter.
Kremsmünster ...	Wagner	86	54	46
Aix la Chapelle ...	Polis	60	54	46
Batavia, Java ...	Van d. Stok ...	9	52	48
Gotha	Lendicke ...	9	73	27
Germany	Köppen	5	56	44
Glatz County ...	Richter	8	62	38
N. America ...	Hazen	1	57	43
Prague	Gruss	20	51	49
,, ...	,, ...	20	53	47
Göttingen	Meyer	24	54	46
Greenwich	MacDowall ...	13	54	46
Madrid	Ventatasta ...	20	52	48
Providence, R.I.	Seagrave	6	49	51

Prof. Pickering adds:—"The number of observations here collected seems to be large enough to enable us to draw definite conclusions, without fear that further records will revise or neutralise them. From these observations we conclude that there really is a greater number of thunderstorms during the first half of the lunar month than during the last half, also that the liability to storms is greatest between new moon and the first quarter, and least between full moon and last quarter. Also we may add that while theoretically very interesting, the difference is not large enough to be of any practical consequence. Thus it would seem that, besides the tides and certain magnetic disturbances, there is a third influence that we must in future attribute to the moon."

FRESH evidence is continually coming to light to prove the artistic skill of the cave men of late Palæolithic times. M. E. Cartailhac has begun a memoir in *l'Anthropologie* (tome xiv. No. 2) on the stations at Bruniquel, on the banks of the Aveyron, which will add materially to our knowledge of these interesting people. Especially remarkable is an engraving, published by the same author (p. 179), of two bands of horses in alignment on a slab of stone from the main cave at Chaffaud, Vienne. This is the first example of regular grouping, and an indication of perspective in Palæolithic pictorial art.

THE shell-heaps of the Lower Fraser River, British Columbia, have been carefully investigated by Mr. Harlan I. Smith in connection with the Jesup North Pacific Expedition, and his results are now published, with numerous illustrations, in the *Memoirs* of the American Museum of Natural History, vol. iv. These shell-heaps seem to have certain peculiarities of their own; the objects found in them are more numerous and of higher artistic

value than those found in the coast shell-heaps, and skeletons are frequently found in the former and but rarely in the latter. It is probable that at an early time a migration took place from the interior to the coast and Vancouver Island. This migration carried the art of stone-chipping, pipes and decorative art to the coast. The culture of the ancient people who discarded the shells forming these heaps was in all essential particulars similar to that of the tribes at present inhabiting the same area, but it was under a much stronger influence from the interior than is found at the present time.

ARCHÆOLOGICAL excavations have been made by Lieut. L. Desplagnes in the tumuli of Killi, in the region of Goundam, in the neighbourhood of Timbuktu (*cf. l'Anthropologie*, tome xiv. p. 151). The mounds appear to have been the tombs of chiefs, along with whom were buried women and captives, and large quantities of offerings of various kinds. The originators of these funeral monuments surpassed the existing people of the district in the art of making varnished pottery and in the fabrication of bronze. The presence of marine shells shows that they had relation with maritime peoples, and other objects prove an extensive commerce. There appears to be some evidence that these unknown people were partly related to the Berbers, and that they were overwhelmed by the spread of Islamism in the eleventh century. The author thinks that perhaps certain isolated peoples whom he mentions may be the fugitive remnants of this formerly relatively advanced nation.

A MEMOIR on the geology of North Arran, South Bute, and the Cumbraes, with parts of Ayrshire and Kintyre, has just been issued by the Geological Survey. It is the work mainly of the late William Gunn, with contributions by Sir A. Geikie, Dr. Peach, and Mr. A. Harker, and is an explanation of Sheet 21 of the one-inch map of Scotland. A great variety of subjects is dealt with, as may be gathered from the lengthy table of formations represented, and there is much to justify the statement referred to by the authors, that the geology of Arran is an epitome of that of Scotland. The central granite mass forms the dominant feature, rising to 2866 feet at Goatfell, and it is bordered by the older metamorphic rocks, schists into which, as observed by Hutton more than a century ago, the granite has been intruded. Rocks probably of Arenig age, black schists, cherts and grits, similar to those of Ballantrae, and associated with old lavas and tuffs, have been discovered in the course of the survey. Notable additions have also been made to our knowledge of the volcanic rocks, and especially with respect to a huge volcanic vent, probably of Tertiary age, in which are preserved remnants of Rhætic, Liassic and Cretaceous formations, hitherto unrecognised in the region. Full particulars are given of the granite, and of the dykes and sills of felsite and quartz porphyry, pitchstone, and other rocks. The Old Red Sandstone and the Carboniferous rocks, the determination of the Triassic age of the newer red sandstones, conglomerates and marls, and the accounts of the Glacial phenomena and economic geology, furnish many topics of great interest. The memoir contains ten photographic plates, and is issued at the price of 4*s*.

THE additions to the Zoological Society's Gardens during the past week include a Pinche Monkey (*Midas oedipus*) from Colombia, presented by Mr. E. G. Percy; two Grey-headed Love-birds (*Agapornis cana*) from Madagascar, presented by Miss Luff; a Whistling Swan (*Cygnus columbianus*) from North America, presented by Dr. Cecil French; a Mexican Snake (*Coluber melanoleucus*) from Mexico, presented by Mr. W. G. Kershaw; two Whistling Swans (*Cygnus columbianus*), a Mocassin Snake (*Tropidonotus fasciatus*), a King Snake (*Coronella getula*), two Mexican Snakes (*Coluber melanoleucus*), a Seven-banded Snake (*Tropidonotus septemvittatus*), two Testaceous Snakes (*Zamenis flagelliformis*), a Striped Snake (*Tropidonotus ordinatus sirtalis*), a Long-nosed Snake (*Heterodon nasicus*) from North America, a Chained Snake (*Coluber catenifer*), a Couch's Snake (*Tropidonotus ordinatus couchi*) from California, a Horned Lizard (*Phrynosoma cornutum*) from Mexico, two Smooth Snakes (*Coronella austriaca*), an Ocellated Sand Skink (*Chalcides ocellatus*), European; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, a Common Rat Kangaroo (*Potorous tridactylus*), two Brush Bronze-winged Pigeons (*Phaps elegans*) from Australia, a Banded Aracari (*Pteroglossus torquatus*) from Central America, a Rat-tailed Opossum (*Didelphys nudicaudata*), a Salvin's Amazon (*Chrysotis salvini*) from South America, two Cutthroat Finches (*Amadina fasciata*) from West Africa, deposited; a Yak (*Poephagus grunniens*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET 1903 *c*.—The following elements and ephemeris have been computed by M. G. Fayet, Paris, from observations made on June 22, 24, and 27, and published in *Circular* No. 60 of the Kiel Centralstelle:—

Elements.

T = 1903 *Aug.* 28·4715 (*M.T. Paris*).

$$\left.\begin{aligned}\omega &= 125^\circ\ 56'\ 53''\\ \Omega &= 293\ \ 38\ \ 40\\ i &= 84\ \ 6\ \ 48\end{aligned}\right\}1903\cdot0.$$

$$\log q = 9\cdot539534$$

Ephemeris 12*h*. (*M.T. Paris*).

1903	α h. m. s.	δ ° '	log Δ	Brightness
July 5	21 27 33	+12 10·9	9·6105	4·5
,, 9	21 6 46	+24 44·8	9·5213	7·6
,, 13	20 26 15	+38 57·9	9·4322	12·9
,, 17	18 53 22	+60 43·0	9·4424	14·1
,, 21	15 46 14	+68 40·8	9·4948	12·9

On July 13 the comet will, according to the above ephemeris, be about 7m. 20s. following, and 58'·9 south of γ Cygni, whilst on July 21 it will be seen in the constellation Draco a little more than one-third the distance from γ Ursæ Minoris to η Draconis on a straight line joining these two stars.

The above scale of brightness takes for its unit value the brightness at the time of discovery, and on June 25, when the value on this scale was about 1·4, M. Pidoux recorded that the comet was equal in brightness to an eighth magnitude star.

PENETRATIVE SOLAR RADIATIONS.—In a paper communicated to No. 24 of the *Comptes rendus*, M. R. Blondlot describes some simple experiments he has performed which appear to show that certain rays (which he calls "the *n* rays") emitted by the sun are capable of passing through various kinds of wood, metals, &c. He placed a fine glass tube containing a phosphorescent material, *e.g.* sulphide of calcium, in a darkened room in which there was a window exposed to the sun, but closed by means of an oaken shutter 15mm. thick, and then found that the phosphorescent material, which he had previously exposed for a very short time to feeble sunlight, continued to glow, but if a plate of lead were interposed between the shutter and the tube the phosphorescence became feebler, whilst it again increased when the lead was removed. Then an oaken joist 3cm. thick, a piece of cardboard, and several plates of aluminium were successively interposed, and the

phosphorescence emitted did *not* diminish, but a thin layer of pure water entirely arrested the *n* radiations. These radiations may be concentrated by a quartz lens, but are regularly reflected by a polished glass surface, whilst an unpolished glass surface diffuses them.

THE SPECTRA OF METALS AND GASES AT HIGH TEMPERATURES.—In No. 25, vol. xxxviii., of the *Proceedings* of the American Academy of Arts and Sciences, Prof. J. Trowbridge gives the details and results of an exhaustive series of experiments on the spectral phenomena observed when gases and metals are together subjected to high temperatures. Employing a large variety of conditions as to the temperature employed, the size of the capillary tubes and the materials from which they are made, and the distance and material of the poles, Prof. Trowbridge arrives at several interesting conclusions, all of which tend to show that in many cases the lines obtained are possibly due to products of the interactions between the gas, the poles, and the containing tube, which take place at high temperatures, rather than to the elements themselves. For instance, the metallic lines obtained from terminals placed 1cm. apart in rarefied air, or hydrogen, were reversed, the reversal coinciding in position with the line obtained in ordinary air, but the line was much broadened on the least refrangible side. The author suggests that this indicates the presence of a gaseous product, probably due to the oxidation or hydration of the poles. Again, when highly heated and rarefied hydrogen, or air, was passed through a tube of amorphous silicon or glass, broad bands, coinciding with the fainter silicon lines obtained under ordinary conditions, were produced, and Prof. Trowbridge believes that in the case of highly refractive metals, such as silicon, these bands are not really due to the metals themselves, but to the interaction between the metals and gases present.

The experiments showed that iron lines did not appear under what seemed to be favourable conditions, whilst aluminium lines did appear under these conditions. For this reason the author enters a *caveat* as to the care it is necessary to exercise when classifying stars solely from the variations in the appearances of their respective spectra.

ZENITH-TELESCOPE RESULTS.—In vol. ii. part i. of the *Publications* of the University of Pennsylvania (Series in Astronomy), Mr. C. L. Doolittle, director of the Flower Observatory, gives the results obtained from the observations made with the zenith-telescope during the period September 6, 1898, to August 30, 1901. After describing the corrections applied to the observed values, the report gives full details of each observation and its corrections, and then gives the values of the "aberration constant" determined during 1898–1899 and 1900–June, 1901, as $20''.540 \pm 0''.0103$ and $20''.561 \pm 0''.0085$ respectively. A curve and a set of tables, showing the variation of latitude at Philadelphia from October 1, 1896, to August 30, 1901, are also included in the report.

PHOTOMICROGRAPHY WITH A BROWNIE CAMERA.

THIS article does not put forth anything new in principle, but is the explanation of a simple method by which any student can, with little trouble and little expense, produce his own photographs of microscope objects, the idea being to direct attention to the inexpensiveness of the necessary apparatus.

The apparatus required includes only a small microscope and a light "fixed-focus" camera, and, of course, the necessaries for developing the negatives. The writer used a microscope of the rigid type generally regarded as little more than a toy, and worth only a very few shillings, and a Brownie Kodak. The instruments need practically no alterations to make them fit for use; the utmost that need be done is this:—Cut a piece of rather thick cardboard the same size as the front of the camera, and in the centre of it make a round hole to fit the eye-piece of the microscope. Glue this to the camera front.

In use the microscope is focused on object for distinct vision for a normal eye. If the experimenter be long- or short-sighted, then he must use appropriate spectacles.

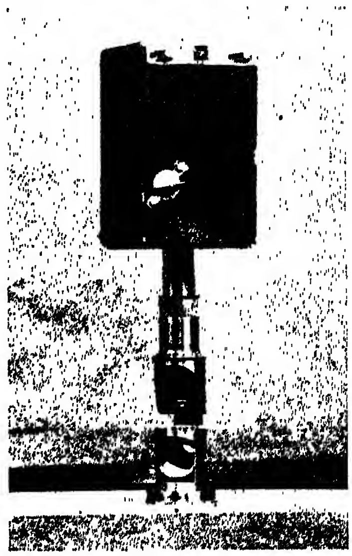


FIG. 1.

The light issuing from the eye-piece is thus rendered parallel, and if the camera be placed on the top of the eye-piece an image of the object will be in focus on the sensitive film. Of course, the optical axes of the camera and microscope must be parts of the same straight line, and the card glued to the camera is to assist the centring. The visual field is the exact area photographed.

Rhyolite. Olivine Diorite.

FIG. 2.

The exposure is made in the usual way, using the camera shutter. In the middle of a fine day exposures of from one to two minutes have been found ample, while in the evening ten or twenty minutes are necessary, using plates of the speed generally known as "Special Rapid." The Brownie camera is made for roll-films, but plates may be used thus:—The camera back is opened and a plate $2\frac{1}{4}'' \times 2\frac{1}{4}''$ laid on the frame over which the film is generally passed. On the back of the plate is placed a piece of black paper or thin card, and the back closed. This paper is necessary in order to exclude the light from the little red window, which is not non-actinic.

After exposure development is proceeded with in the ordinary way, using pyro-soda or any other developer the experimenter may prefer.

It will be seen from the specimens that the definition is, of course, not of the highest order, but considering the apparatus, one must not expect too much. The photo-

graphs are certainly more accurate than the student's sketches would be, and are probably made in less time. The lack of sharp focus at the edges is due to the cheap microscope used, and not to the camera, which is good enough for combination with any instrument likely to be employed in this manner. Any microscope and any similar camera may be used. The specimens reproduced show a magnification of ×20 diameters.

Considering the simplicity of the method and the slight cost of the apparatus, the idea should recommend itself to a good many students. W. MOSS.

SEISMOLOGICAL NOTES.

IN the nineteenth report of the Tokio Physico-mathematical Society Dr. F. Ōmori gives two short papers on the velocity with which earthquake waves are propagated. In calculating these velocities it is assumed that the paths followed are in all cases arcual, and that a correct velocity is arrived at by dividing the distance between Tokio and a station in Europe by the difference in time at which similar phases of movement were recorded at two such places. As to the soundness of this method, excepting as applied to the large waves of earthquakes, opinions vary. In another note by the same investigator, attention is drawn to the difference in the character of seismograms obtained at two stations about a mile apart. At one station, two distinct groups of maximum movements are shown. These are explained as the longitudinal and transverse components of elastic vibrations simultaneously produced at the seismic centre. At the other station the records are described as a series of maximum movements at fairly regular intervals. This feature is attributed to a rhythmic interference between the proper oscillation of a soft surface soil and the movements of an underlying harder ground. In a discussion on *pulsations* or small movements of non-seismic origin, it is shown that the period of these corresponds to the period of preliminary tremors, from which it is inferred that for both of these movements their periods depend upon the nature of the soil where they are observed.

The thirteenth number of the *Publications* of the Earthquake Committee (Tokio) consists of a series of papers also by Dr. F. Ōmori, several of which are identical with those to which we have just referred.

Long registers are given for the year 1900, the earthquakes in each of which originated in the same locality or at great distances from the observing stations in Tokio. In the earthquakes with distant origins, the periods of the preliminary tremors do not depend upon their duration, the duration of preliminary tremors being proportional to the distance such earthquake motion may have travelled. This is probably true for other phases of motion, and it has also been shown to exist for *macro-seismic* disturbances.

Other analyses relate to the relative magnitudes of earthquake movements, direction of first displacements, and matters of greater or less seismological interest.

In the *Bulletin* issued by the Philippine Weather Bureau for December, 1902, the Rev. Marcial Solá, S.J., gives an account of a violent earthquake which originated near Manila, and was recorded at many stations around the world. Materials from twenty-three of these stations are analysed, and the velocities with which waves were propagated through and round the world have been calculated. For the first waves, along chords corresponding to axes less than 46°, the velocity was 10·2km. per second., whilst for longer paths, up to 154°, this became 12·4km. per second. The maximum phase, travelling on arcs, did so with a velocity of 3·1km. per second, the lengths of the waves varying between 106 and 181km. Although these results fall closely in line with those of other observers, it may be pointed out that, if the time at which the earthquake originated was known, the values for velocities arrived at would be somewhat reduced.

In the last *Bolletino* (vol. viii. No. 8) issued by the Seismological Society of Italy, Dr. Giulio Grablovitz contributes a short paper describing a modified form of his *vasca sismica*. This is a circular tank about 1·5m. in diameter and 1m. in depth. On this there is a floating tray, the movement of which at the time of earthquakes is recorded upon a rotating cylinder. The chief feature in the records obtained from such a fluid pendulum, the period of which is short, is that the indicated amplitude of the preliminary tremors is usually more pronounced than that shown by other types of instruments.

Dr. G. Agamennone gives an account of the earthquake which, on June 29, 1896, originated in Cyprus, and was recorded at stations more than 3000km. from its centre. With the assumption that the wave paths were *arcual*, the first movements were propagated with speeds slightly exceeding 13km. per second. It may be pointed out that these values would be reduced had the wave paths been considered *chordal*. The remainder of the *Bolletino* is taken up with earthquake registers. These commenced in January, 1895, and have now reached June, 1901. Inasmuch as they do not simply refer to earthquakes noted in Italy, but to earthquakes which have spread over the whole world, for this class of earthquakes the Italian catalogue is for many purposes the most valuable which seismologists possess.

ETHNOGRAPHICAL STUDIES IN NORTH QUEENSLAND.[1]

THE student of folk tale, custom and belief will find in the last *Bulletin* issued by Dr. Walter E. Roth a mine of trustworthy data which will furnish new illustrations of the working of the mind of a primitive people. Though similar stories, ideas and habits may have been recorded previously by various observers in this and other parts of the world, yet none the less this record is of value as it confirms the older accounts in their broad aspects, and gives instructive variations in details. Some of the customs appear to be peculiar to the North Queensland natives, while others are definitely Australian in character. The information is given in those short, pithy paragraphs to which Dr. Roth has accustomed us; at times we could wish for more detailed information, but, on the other hand, we are spared any unnecessary verbiage, and there are no hypotheses or guesses. It is a comfort not to have to pick out facts from a mass of writing, and also to feel that the information can be absolutely trusted.

Readers of Spencer and Gillen's memorable book, "The Native Tribes of Central Australia," will remember that the Arunta do not recognise the relation between the sexual act and conception; this seemed so strange that it was felt that some confirmation of this ignorance was needed, and Dr. Roth now gives it to us, for he says that though the relation is not recognised among the Tully River blacks so far as they themselves are concerned, it is admitted as true for all animals—indeed, this idea confirms them in their belief of superiority over the brute creation. Dr. Roth offers the following explanation of this strange belief:—"When it is remembered that as a rule in all these northern tribes, a little girl may be given to and will live with her spouse as wife long before she reaches the stage of puberty—the relationship of which to fecundity is not recognised—the idea of conception not being necessarily due to sexual connection becomes partly intelligible." Various other beliefs and customs connected with sexual history are narrated, amongst which may be mentioned the seclusion of girls at puberty, at which period, as in the western islands of Torres Straits, as Dr. Seligmann has pointed out, the girls are half-buried and surrounded by a leafy bower.

Numerous magical practices are described; many have for their object the procuring of disease or death, others are curative, some induce success in love, while others give luck in hunting or fishing. A vital principle, breath, thought, will-power, soul, spirit, or whatever it may be termed, is recognised by all the tribes, but some deny this to animals and plants, while others will grant it to animals but not to plants. Dr. Roth's explanation of the opinion widely spread among the white men that the blackfellow believes he is transformed into a white man at death, or, as it is expressed, "black jump-up white-fellow," is that the vital principle, or spirit, of a native may be re-incarnated in a white man, and not that his body is actually transformed into that of a European. A number of illustrations further add to the value of this important publication.

A. C. H.

[1] North Queensland Ethnography, *Bulletin* No. 5. "Superstition, Magic and Medicine," by Walter E. Roth, the Northern Protector of Aboriginals, Queensland. (Home Secretary's Department, Brisbane, C.A. 5, 1903.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Allied Colonial Universities Conference is to be held at Burlington House to-day, July 9. Mr. James Bryce is to preside at the morning session, and Lord Strathcona and Mount Royal at the afternoon session. Official representatives have been appointed by the governing bodies of universities throughout the Empire to attend the conference. The universities of England and Wales, Scotland, and Ireland will be represented, and also fourteen Canadian universities, three Australian universities, New Zealand University, and the Cape of Good Hope University. Among the representatives appointed by colonial universities we notice the names of Prof. H. T. Bovey, F.R.S., Prof. E. Rutherford, F.R.S., Prof. J. G. MacGregor, F.R.S., Prof. R. Threlfall, F.R.S., Prof. Horace Lamb, F.R.S., and Prof. T. H. Beare. The following resolutions will be submitted:—(1) That in the opinion of this conference it is desirable that such relations should be established between the principal teaching universities of the Empire as will secure that special or local advantages for study, and in particular for post-graduate study and research, be made as accessible as possible to students from all parts of the King's dominions. Proposed by the Vice-Chancellor of Cambridge, seconded by the Vice-Chancellor of McGill University, Montreal, and supported by the principal of the University of London. (2) That a council, consisting in part of representatives of British and colonial universities, be appointed to promote the objects set out in the previous resolution, and that a committee be appointed to arrange for the constitution of the council. Proposed by the Pro-Vice-Chancellor of Oxford, seconded by Prof. R. Threlfall (representing the University of Sydney, New South Wales), and supported by the principal of the University of Birmingham. In addition to the abovenamed, Lord Kelvin, Sir Henry Roscoe, Prof. Rutherford, and several other representatives of universities have signified their intention of supporting the resolutions. Mr. R. B. Haldane, Sir Michael Foster, K.C.B., F.R.S., Sir Norman Lockyer, K.C.B., F.R.S., Mr. Fletcher Moulton, F.R.S., Prof. H. L. Callendar, F.R.S., Prof. J. A. Ewing, F.R.S., and Dr. H. P. Gurney (principal of the Durham College of Science) will also be among the speakers. A dinner will be held at the Hotel Cecil to-morrow evening, when the Prime Minister will occupy the chair.

IN an address delivered at a congregation of the University of Birmingham on Saturday last, the Chancellor, Mr. Chamberlain, described the progress and purpose of the university, and referred to the scheme for a postgraduate institute of applied science in London. In the course of his remarks Mr. Chamberlain said that, shortly after the idea of a university for Birmingham and district was put forward, the promoters found that much more than had originally been contemplated would be necessary to keep abreast of modern work and modern enterprise. Accordingly, a million of money was asked for instead of the quarter of a million originally contemplated. Up to the present time donations to the amount of something like 450,000*l.* have been received. Of that amount, 300,000*l.* are being spent in the first buildings of the new university. The City of Birmingham has voted a contribution equivalent to a halfpenny rate, which will provide an annual contribution which at the present time is between 6000*l.* and 7000*l.* a year. The county councils of Worcestershire and Staffordshire have contributed a present sum of 500*l.* per annum each. As to the purpose of the university, the view is perpetually borne in mind that it is to be a seat of all learning and an establishment for the promotion of original research. Every branch of learning which has its technical side will be separately represented by its own library, its own laboratory, and its own museum. The constitution of the university has undoubtedly given a stimulus to the higher education throughout the United Kingdom. Following the example of Birmingham, the colleges of Liverpool and Manchester, and also of Leeds, are developing themselves on the technical side, and are applying for independent charters as separate universities. And a scheme has been put forward for a technical college in London with similar objects to those of Birmingham University. When all these institutions are completed, there will be in our country, as there is already in Germany and in North America, a network of institutions all of which may help each other. These modern universities must of necessity be specialised to suit the conditions of the district in which they are established. May it not be, then, in the future that ideas, and even students, may be exchanged, and that many students, as in Germany already, may find their full course can only be completed by going from one university to another and seeking in each what it is best fitted to afford?

THE Lord Mayor of London laid the foundation stone of the new buildings of the University College of Sheffield on June 30. These buildings are part of a large scheme of extension and consolidation, and will cost more than 110,000*l.* The new metallurgical extension, containing new furnaces, is practically completed. The extensions for engineering, and new accommodation for electrical engineering, are in process of erection. The block for which the foundation has just been laid is situated on a site about three-quarters of a mile from the centre of the city, on the ridge of a hill, 420 feet above sea level, and adjoins the Weston Park on two sides. The general plan is that of buildings surrounding a quadrangle, with an annexe for the library. The buildings on three sides of the quadrangle are to be erected immediately, the fourth side hereafter when required. The building on the west side of the quadrangle, with a front to the park, is for the departments comprising arts, physics, biology, chemistry, law and commerce. That on the north side—also with a front to the park—contains accommodation for architecture, and the whole of the medical department, comprising anatomy, physiology, pathology, bacteriology, and public health, together with lecture rooms and medical library. It is expected that college work will be in full swing in the new buildings in October, 1905. As the result of an appeal that was made a short time ago for funds which would enable a University of Sheffield to be constituted, the sum of 51,400*l.* has been subscribed towards the new buildings, but it is understood that a further sum of 10,000*l.* is required to complete the portion now to be proceeded with, whilst 10,000*l.* will also be needed for the library, and about 10,000*l.* to complete the equipment of the various laboratories. It is desired to make adequate provision for, and to grant degrees in, the four following faculties:—(1) Arts, including education and commerce; (2) pure science; (3) medicine; and (4) applied science (engineering, metallurgy and mining). The City Council has pledged itself by a unanimous vote, in case university powers are obtained, to grant an annual sum not exceeding one penny in the pound out of the rates, equivalent to a capitalised sum of about 200,000*l.* To carry out the proposed university scheme in its entirety, a further annual income of 5000*l.* would be required.

AT University College, London, on Monday, Prof. E. H. Starling, F.R.S., Dean of the Faculty of Science, in his report of the work of the last session, referred to the scheme for the incorporation of the college into the University of London, and the suggested institute for advanced technical work. He remarked that certain conditions had to be fulfilled before the incorporation could take place—namely, the provision of new buildings for the clinical school and for the boys' school. The financial means to completely carry out these objects were still wanting. The college would need 40,000*l.* for the building of the clinical school and 60,000*l.* for the boys' school. Believing that money would be forthcoming for so essential a step in the provision of higher education for London, the council of the college and the university were cooperating in drawing up a Bill to enable incorporation to take place, and they hoped that the Bill would be introduced next session. It was proposed in the Bill to seek general powers for the incorporation of other institutions into the university. Only by incorporation of these interests into one, and by giving to the Senate of the university full control over the whole university teaching of London, could they hope to be strong enough to develop higher education and research in accordance with the growing needs of the time. This being their policy, it was with some apprehension that he had seen the publication of a scheme for creating a body, well equipped and endowed, within the university, but not belonging to the university. If the control of the new institution was secured to the university it would be certain to succeed, and they

need not trouble about the self-contradictory statements of the aims and the objects of the new institution with which they were favoured by enthusiastic amateurs.

A VACATION course in practical and clinical bacteriology will be held at King's College, London, commencing Wednesday, August 5, and ending Saturday, August 15. Names must be sent in as soon as possible to the secretary or to Prof. Hewlett.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 11.—"On the Propagation of Tremors over the Surface of an Elastic Solid." By Horace **Lamb**, F.R.S.

The paper treats of the propagation of vibrations over the surface of a "semi-infinite" isotropic elastic solid, *i.e.* a solid bounded only by a plane. For purposes of description, this plane is conceived as horizontal, and the solid as lying below it.

The vibrations are supposed due to an arbitrary application of force at a point. In the problem most fully discussed this force consists of an impulse applied normally to the surface; but some other cases, including that of an internal source of disturbance, are also considered. Owing to the complexity of the problem, attention is concentrated for the present on the vibrations as they manifest themselves at the free surface, and the modifications which the latter introduces into the character of the waves propagated into the interior are accordingly not examined minutely.

The investigation claims interest on theoretical grounds, and also in relation to the phenomena of earthquakes. Attempts to interpret seismic phenomena by the light of elastic theory have hitherto been based, for the most part, on the general laws of wave-propagation in an unlimited medium, as developed by Green and Stokes; but Lord Rayleigh's discovery of a special type of surface-waves has made it evident that the influence of the free surface in modifying the character of the vibrations is more definite, and more serious, than had been suspected. The present memoir seeks to take a further step in the adaptation of the theory to the actual conditions, by investigating cases of *forced* waves, and by abandoning the restriction to simple-harmonic vibrations.

It is found that the surface disturbance produced by a single impulse of short duration may be analysed roughly into two parts, which we may distinguish as the "minor tremor" and the "main shock," respectively. The minor tremor sets in at any place, with some abruptness, after an interval equal to the time which a wave of longitudinal displacement (in an unlimited medium) would take to traverse the distance from the source. Except for certain marked features at the inception, and again (to a lesser extent) at an epoch corresponding to that of direct arrival of transversal waves, it may be described, in general terms, as consisting of a long undulation leading up to the main shock, and dying out gradually after this has passed. Its time-scale is more and more protracted, and its amplitude more and more diminished, the greater the distance from the source. The main shock, on the other hand, is propagated as a solitary wave (with one maximum and one minimum, in both the horizontal and vertical displacements); its time-scale is constant, and its amplitude diminishes only in accordance with the usual law of annular divergence, so that its total energy, unlike that of the minor tremor, is maintained undiminished. Its velocity is that of free Rayleigh waves, and is accordingly somewhat less than that of waves of transversal displacement in an unlimited medium.

"A Method for the Investigation of Fossils by Serial Sections." By Prof. W. J. **Sollas**, F.R.S.

Mechanical difficulties preclude the study of fossils by serial thin slices, but serial polished surfaces may be obtained at any desired degree of proximity, and these, when the fossil and its matrix offer sufficient optical contrast, serve most of the purposes of thin slices. They may be photographed under the microscope, so as to furnish a trustworthy and permanent record. The sections may be used to obtain reconstructions of the fossil in wax. Several fossils have been successfully studied in this way, such as *Palaeospondylus Gunni, Ophiura Egertoni, Lapworthura Miltoni, Monograptus priodon,* and *Palaeodiscus ferox.* The sections are obtained at regular intervals, usually of 0·025mm., by means of an apparatus designed for the purpose by the Rev. F. Jervis-Smith, F.R.S., reader of mechanics in the university.

"An Account of the Devonian Fish, *Palaeospondylus Gunni,* Traquair." By Prof. W. J. **Sollas**, F.R.S., and Igerna B. J. **Sollas**.

June 18.—"Some Preliminary Observations on the Assimilation of Carbon Monoxide by Green Plants." By Prof. W. B. **Bottomley** and Mr. Herbert **Jackson**. Communicated by Prof. J. Reynolds Green, F.R.S.

"The Bionomics of *Convoluta roscoffensis.*" By Dr. F. W. **Gamble** and Frederick **Keeble**, M.A.

Convoluta is a minute green Turbellarian organism that lives in such prodigious numbers on the coast of Brittany as to cover long stretches of the beach with a thick green scum.

Previous observers have directed attention to the fact that Convoluta is not merely an animal, but is an association of an animal and a plant, or plant-like organism, which is represented by the green cells. These cells contain chlorophyll, perform photosynthesis, and store starch, but, unlike algal cells, they have no cell-wall, and they are believed to have no power of surviving the death of the animal tissue. Whether they are exceptional animal cells or infecting plant-cells, or algæ acquired in past time and now inherited, is unknown. But it is supposed that the life of the animal has been modified to suit their requirements, that from their reserves the animal is fed, and that to the renewal of these reserves its movements are directed.

The present paper is an attempt to gain further insight into this strange problem. Dealing first with the question of food, the authors show what rays of light are effective in producing a surplus of starch, but they believe that this reserve does not furnish the source of food on which the animal tissue of Convoluta is nourished; for not only does this starch disappear with extreme slowness (7–8 days) in darkness, but direct evidence is forthcoming that in all stages of development Convoluta can, and does, ingest, that in the earlier ones diatoms and algæ are normally ingested and digested, and that in the later stages the green cells are bodily aggregated and digested in the gut.

Passing to the development of the green cells, the authors find the first trace of these cells as colourless, nucleated structures in the gut of the recently hatched animal. Direct proof of the intrinsic or extrinsic origin of these colourless cells is still lacking. The indirect evidence, however, is strongly in favour of the latter mode of origin. On this view Convoluta makes a pure culture from a mixed infection.

Further analyses than heretofore of the effects of light, heat, gravity, and other agencies on the behaviour of Convoluta are given. The *tonic,* even more than the *tropic,* effect of light determines the periodic tidal movements, now to the surface of the sand, and now below the surface. The direct tropic effect of light is greatest in the green rays, absent in the blue, and reversed in the red. The effect is modified by the absorbing or scattering character of the background, and by the age of the animal. At the moment of hatching, Convoluta is aphototropic.

Geotropic response is not exhibited by those Convoluta which fail to develop their otolith. Normally it is shown from the moment of birth.

The paper concludes with a description of the daily and lunar variations in the size and behaviour of the colonies, and with an explanation of these variations in terms of the tropisms and other habits of Convoluta.

"The Spectra of Neon, Krypton, and Xenon." By E. C. C. **Baly**, Lecturer on Spectroscopy in University College, London.

The gases were illuminated by the passage of the discharge from an induction coil through them under reduced pressures. Vacuum tubes were filled with each one of them, and the glowing gas in a capillary portion was examined "end on" through a quartz window. Considerable difficulty was experienced in the use of the tubes, owing to the disintegration of the electrodes and the absorption of

the gas when the current was kept passing for long periods. The measurements were all made upon photographs taken with a Rowland concave grating of 10 feet focus and 14,438 lines to the inch; the first three orders of spectra were employed, and nearly all the chief lines were measured in two orders; the probable error of the measurements is less than 0·03 Ångström unit. Each gas gives bright-line spectra, krypton and xenon having two and neon one; the second spectra of krypton and xenon are produced by placing a Leyden jar and a spark gap in the circuit with the vacuum tube.

Physical Society, June 26.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—Dr. **Waller** gave a demonstration of the effect of light on green leaves. The origin of these researches was the result of the consideration of the retinal effects after light stimulation, and the wish to have a sensitive surface naturally spread out for examination. The effect of light is to produce a current (of an E.M.F. of the order of 0·01 volt), at first from the illuminated to the dark parts in the leaf, and later (or as an after-effect) from dark to illuminated. These currents are apparently an index of two opposite processes in the leaf, *i.e.* dissimilation and assimilation, and give very close analogies to the analogous processes in animal tissues (*e.g.* nerves). Dr. Waller also demonstrated the "blaze" currents in animal and vegetable tissues. These are seen when a strong exciting current (such as an induction-shock of sufficient voltage) is led through a pair of non-polarisable electrodes, and these are then connected with a galvanometer. An electrical response (of greater energy than the exciting current) is given in a direction commonly homodrome to the latter, *i.e.* in the reverse direction to the ordinary polarisation counter-currents. This "blaze" response is the algebraic sum of post-anodic and post-kathodic currents; the resultant is commonly homodrome, but an antidrome blaze, distinguished from polarisation by its much greater order of magnitude, is also seen. Dr. Waller also showed two methods for the quantitative estimation of chloroform vapour in air. The first was by receiving the mixed gases into a flask of known capacity, absorbing the chloroform by means of olive oil, and reading the reduction of pressure by a manometer. The second was by the simple weighing of a light flask, first filled with air, then filled with mixed air and chloroform vapour.—Dr. N. H. **Alcock** exhibited a method of determining the temperature-limits of nerve activity in warm-blooded and cold-blooded animals. The higher limit was obtained by immersing the isolated nerve in 1·05 per cent. NaCl solution. It lies between 40° C. and 42° C. in the frog, 48° and 49° in the mammal, and is at 53° in the bird, corresponding closely to the coagulating point of the tissue proteids. The lower limits were obtained by cooling the nerve-chamber as a whole, and taking the temperature of the nerve with a compensated thermo-junction. The limits were −3°·5 C. for the frog, +3°·8 C. for the mammal, +6°·8 C. for the bird, giving a range of nerve-action of 45° C. to 46° C. for all animals. The method, therefore, permits of an hitherto impossible analysis of actually living nerve-substance.

Zoological Society, June 16.—Dr. F. Du Cane Godman, F.R.S., vice-president, in the chair.—Dr. H. **Woodward,** F.R.S., made a communication from Miss Dorothy M. A. Bate which contained a description of the remains of an extinct species of Genet from a Pleistocene cave-deposit in Cyprus, and which it was proposed to name *Genetta plesictoides*, sp. n.—Mr. G. A. **Boulenger,** F.R.S., described a new species of Gobiid fish from British New Guinea under the name of *Rhiacichthys novae-guineae*.—Mr. G. A. Boulenger also described the following five new species of reptiles from British New Guinea:—*Lygosoma milnense, L. granulatum, L. pulchrum, L. pratti,* and *Toxicocalamus stanleyanus*.—A second instalment of a paper, by Mr. Cyril **Crossland,** on the Polychæta of Zanzibar and British East Africa, contained descriptions of three new species of Marphysa, viz. *M. macintoshi, M. simplex,* and *M. furcellata*, and a new key to the known species of that genus. It also contained remarks on *Lysidice collaris* and its variations, and on the two species *Diopatra neapolitana* and *Onuphis holobranchiata*, which had hitherto not been met with in East Africa.—A communication on the parasites collected by the "Skeat Expedition" to Lower Siam and the Malay Peninsula in the year 1900 was read by the secretary on behalf of Mr. Arthur E. **Shipley.** The author stated that the area in which the collection was gathered had been hitherto unsearched by students of parasites, and referred to the high proportion of new forms that had been obtained. Among these were a new species of Tetrarhynchus, found in an Echinoderm, and an undeterminable species of Tetrarhynchus found in a sea-snake. The occurrence of these forms in such hosts was practically new to science. There were also described eight new species of Acanthocephala.—A communication from Messrs. Louis **Murbach** and Cresswell **Shearer** dealt with a collection of Medusæ from the coast of British Columbia and Alaska made in 1900. Specimens of fourteen species—of which five were new—were contained in the collection, and these were remarked upon or described.—Mr. F. E. **Beddard,** F.R.S., read a paper upon the modifications of the Syrinx in the Accipitres. The syringes of a number of genera were described in detail, and it was pointed out that the group could be divided into two families according to the form of this organ.

Chemical Society, June 17.—Prof. W. A. Tilden, F.R.S., in the chair.—The Longstaff medal was presented to Prof. W. J. Pope in recognition of his researches on the stereochemistry of compounds of elements other than carbon.—The following papers were read:—The estimation of arsenic in fuel, by Prof. T. E. **Thorpe,** F.R.S. A known quantity of the finely-powdered fuel is burnt in a stream of oxygen, the issuing gas is passed through a suitable absorption apparatus, and the absorption liquid, as well as the ash of the fuel, are tested for arsenic.—The electrolytic estimation of minute quantities of arsenic, more especially in brewing materials, by Prof. T. E. **Thorpe,** F.R.S. A special electrolytic arrangement is adopted whereby the electrolysis of dilute sulphuric acid is brought about in presence of the arsenical liquid, and the formation of arseniuretted hydrogen is detected in the usual way.—Crystallised ammonium sulphate and the position of ammonium in the alkali series, by Dr. A. E. H. **Tutton.** The molecular constants of crystals of ammonium sulphate indicate that the substitution of two ammonium groups for the two atoms of potassium in potassium sulphate produces approximately the same change as the substitution of two atoms of rubidium; on the other hand, the specific constants show that the ammonium radicle exerts a certain influence peculiar to itself in the series of alkali sulphates.—The action of hydrogen on sodium, by Mr. A. **Holt.**—The action of halogens on compounds containing the carbonyl group, by Dr. **Lapworth.** It is shown that the bromination of these compounds takes place more rapidly in presence of acids and alkalis.—Reactions involving the addition of hydrogen cyanide to carbon compounds, by Dr. **Lapworth.**—The acetoacetic ester synthesis, by Messrs. **Hann** and **Lapworth.**—Rimu resin, by Prof. **Easterfield** and Mr. **Aston.** This resin consists principally of rimuic acid $C_{18}H_{30}O_3$.—Note on the karaka fruit, by Messrs. **Easterfield** and **Aston.** This material, which in the raw state is bitter and poisonous, contains the glucosides karakin and corynocarpin. When an aqueous extract of the fruit is distilled, a distillate containing hydrocyanic acid is obtained.—The slow oxidation of methane at low temperatures, by Messrs. **Bone** and **Wheeler.**—The alkylation of sugars, by Prof. **Purdie** and Mr. **Irvine.**—Trimethyl-α-methylglucoside and trimethylglucose, by Messrs. **Purdie** and **Bridgett.**—Note on the corrosion of an Egyptian image, by Mr. H. **Bassett,** jun. An examination has been made of a green coating covering a bronze image, probably dating from the period 200–100 B.C., recently found in the delta of the Nile. The principal constituents are cupric chloride and oxide, lead oxide, stannic oxide, water, silica, and small quantities of nickel and iron oxides.—The oxidation of pinene with chromyl chloride, by Prof. **Henderson,** Messrs. **Gray** and **Smith.**—Some physical and chemical properties of strong nitric acid, by Messrs. **Veley** and **Manley.** It is shown that the density, contraction, refractive index, and electrical conductivity vary regularly until the concentration of the acid reaches 92 per cent., but from this point to 100 per cent. the variation is exceptional. These facts are in harmony with Hartley's view that acid of 96 per cent. strength contains a definite compound of the formula $3H_2N_2O_6,H_2NO_4$.—Notes on ozone, by Mr. **Inglis.** The molecular state of

ozone in acid and aqueous solutions cannot be ascertained by solubility determinations, since equilibrium between the gas and its solutions cannot be secured.

Geological Society, June 10.—Mr. J. J. Harris Teall, F.R.S., vice-president, in the chair.—On primary and secondary devitrification in glassy igneous rocks, part i., by Mr. John **Parkinson**. The types of primary devitrification as found at Obsidian Cliff are briefly reviewed, and reference is made to the conditions which favoured primary devitrification at Obsidian Cliff. After a brief reference to secondary devitrification, this part of the paper concludes with a summary in which the several relations of secondary to primary devitrification-structures are given.—Part ii., by Prof. T. G. **Bonney**, F.R.S. Certain conditions, such as slow cooling, supersaturation, and the presence of inclusions are favourable to crystallisation, some special cases of which are discussed in the paper. The structures thus formed in rocks may be classified as (1) the linear, and (2) the granular, and the former may be subdivided into (*a*) the rectilinear, (*b*) the curvilinear. Spherulitic structure in its simpler form falls under (*a*), and is at first little more than a radial grouping of molecules, the process becoming gradually more complicated. Of this, "graphic" or "pegmatitic" structure is a final stage, where two minerals are crystallising out of a solution, and one has slightly the advantage over the other, so that it virtually forms a skeleton-crystal. Into this the ordinary radial growth of a spherulite may be seen to pass; likewise also examples of (*a*) into those of (*b*), the latter being due to the "leading" mineral meeting with a rather stronger resistance, as if a crystal were forming in a very tough jelly. The granular structure is discussed, and explanations are offered of its varieties. In conclusion, the relation of some of these structures to an eutectic composition is discussed.—Geology of the Ashbourne and Buxton branch of the London and North-Western Railway—Crake Low to Parsley Hay, by Mr. H. H. **Arnold-Bemrose**. The present paper is a continuation of one published in 1899, and deals with the geology of the next eight miles of this railway.

Royal Microscopical Society, June 17.—Mr. Wm. Carruthers, F.R.S., vice-president, in the chair.—In the absence of Lord **Rayleigh**, his paper on the theory of optical images with special reference to the microscope was read by Dr. Hebb.—Dr. H. **Siedentopf** read a paper on the rendering visible of ultra-microscopic particles and of ultra-microscopic bacilli. The subject was illustrated by microscopes fitted with special illuminating apparatus, various objects, and drawings on the blackboard.—A communication relating to the preceding subject, sent by Dr. Johnstone Stoney, was read by the secretary. There was a lengthy discussion on the three papers, in which Prof. J. D. Everett, Dr. S. Czapski, Mr. J. W. Gordon, Mr. Rheinberg, Dr. C. V. Drysdale, Dr. Beilby, and Mr. Conrad Beck took part. Owing to the lateness of the hour, the following papers were taken as read:—On the "lag" in microscopic vision (continued); an improved horseshoe stage and a micrometric correction for minute objects, by Mr. E. M. **Nelson**; and a method of mounting bacteria from fluid media, by Mr. J. A. **Hill**.

Challenger Society, June 24.—Dr. R. N. Wolfenden in the chair.—Mr. V. H. **Blackman** contributed some notes on Bipolar plants; a comparison of the 259 Arctic and 269 Antarctic Algæ shows that no less than 54 species are found both north and south of the tropics, but not between them; of the larger brown seaweeds not even a genus is common to the two poles.—Dr. **Fowler** read notes on the distribution of some Amphipoda collected by him in the Bay of Biscay at various depths during a cruise in H.M.S. *Research*, 1900; they had been identified by the Rev. T. R. R. Stebbing. Among these were two Arctic cold-water forms, *Scina borealis*, Sars., and *Cyphocaris anonyx*, Boeck., taken between 750–500 fathoms and 300–400 fathoms respectively, but not known from shallow water at low latitudes; and *Hyperioides longipes*, Chevreux, distributed round the 100 fathom horizon as a centre, but not occurring at the surface or at great depths.

CAMBRIDGE.

Philosophical Society, May 18.—Dr. Baker, president, in the chair.—A coleopterous insect embedded in the wall of the human intestine, by Mr. D. **Sharp**, F.R.S. The author gave an account of the finding, by Dr. W. H. Ligertwood, of a living specimen of *Otiorhynchus tenebricosus* embedded in the wall of the intestine of a patient who died in the Wells Asylum. The position of the foreign body was in the ileum about eighteen inches from the ileo-cœcal valve. This beetle is purely herbivorous in its habits.—Exhibition of a rare parasite, by Mr. A. E. **Shipley**.—On the influence of electrons on colloidal solutions, by Mr. W. B. **Hardy**, F.R.S. Specially purified globulin from blood was dissolved (*a*) in a trace of acetic acid, (*b*) in a trace of sodium hydrate. In presence of acetic acid the globulin was found to move in an electric field from anode to kathode, in presence of alkali it moved from kathode to anode. In the former case, therefore, the globulin particles carried a positive charge, in the latter a negative charge. These two solutions were exposed to the radiations from radium bromide, and it was found that the electro-negative solution of globulin was turned into an opaque jelly in three minutes, while the electro-positive solution became more mobile and less opalescent.—On bismuth, by Mr. R. H. **Adie**. The discrepancies between the atomic weight of bismuth as determined by Schneider and Marignac = 208 and by Classen = 208·9, have been hitherto discussed on the assumption that the cause is the presence of lead. The author, by adopting a combination of fractionation as subnitrate and distillation as chloride, has succeeded in obtaining sufficient silica from pure bismuth to account for the low values of the former observers. The determination of the atomic weight and the isolation of a new coloured substance is now proceeding.—On the influence of great dilution on the absorption spectra of highly concentrated solutions of the nitrates and chlorides of didymium and erbium, by Mr. J. E. **Purvis**. The experiments prove that (1) the absorption bands of very highly concentrated solutions of the chlorides of didymium and erbium are not altered when the solutions are highly diluted. (2) The absorption bands of very highly concentrated solutions of the nitrates of didymium and erbium are considerably less diffuse when the solutions are highly diluted. This effect is analogous to that produced in the spectra of some gases and vapours by diminishing the density of the gas or vapour. (3) The absorption bands of very concentrated and very diluted solutions of the chlorides of didymium and erbium are precisely similar to those observed in the very diluted solutions of the nitrates of these two earths.—On a method of estimating the amounts of the oxides of didymium and erbium by means of the absorption bands of their solutions, by Mr. J. E. **Purvis**.—A lecture experiment to illustrate the rotation of a magnetic pole around a straight current, by Mr. P. V. **Bevan**.—Irreversible simultaneous linear reactions, by Mr. H. O. **Jones** and O. W. **Richardson**.

PARIS.

Academy of Sciences, June 29.—M. Albert Gaudry in the chair.—Researches on one and two fluid batteries, by M. **Berthelot**.—On the mechanical analysis of soils, by M. Th. **Schlœsing**. A discussion of the relation between the nature and amount of a substance deposited from suspension in water, and the time taken to settle. Experimental results on sandy, clay, and loam soils are given.—On the influence of the introduction of unsaturated radicles on the rotatory power of active molecules, α-allyl, α-propyl, and δ-methyl-β-cyclopentanonecarboxylic esters, by MM. A. **Haller** and M. **Desfontaines**. The conversion of an aliphatic active molecule into a cyclic molecule is accompanied with a large rise in the rotatory power. The rotatory power of the allyl ester is distinctly higher than that of the propyl derivative.—Observations on the comet 1903 *c*, discovered by M. Borrelly at the Observatory of Marseilles, June 21, by M. E. **Stephan**. The comet possesses a nucleus of the tenth magnitude, and a tail extending 5′ or 6′.—Observations made at the Observatory of Lyons during the partial eclipse of the moon of April 11; final results, by M. Ch. **André**.—Observation of the bright spot of Saturn with the 38cm. equatorial of the Observatory of Toulouse, by M. F. **Rossard**.—The elements of the Borrelly comet, by M. G. **Fayet**. Calculated from observations made at the Paris Observatory. The brightness of the comet will reach its maximum about July 14, and the comet will then be in a position very favourable for observation, and may be visible to the naked eye for some days.—Observ-

ations on the new Borrelly comet made at the Paris Observatory, by M. G. **Bigourdan.**—Observations on the Borrelly comet made with the 31·8cm. equatorial at the Observatory of Algiers, by MM. **Rambaud** and **Sy.**—Observations on the Borrelly comet made at the Paris Observatory, by M. **Salet.**—Observations on the comet 1903 *c* (Borrelly) made at the Observatory of Besançon, by M. P. **Chofardet.**—Observations on the Borrelly comet made with the Brunner 16cm. equatorial at the Observatory of Lyons, by MM. J. **Guillaume** and G. **Le Cadet.**—The influence of altitude on the duration of the reduction of the oxyhæmoglobin in man, by M. A. **Hénocque.** The effect of living at altitudes of 1000 to 2000 metres is to produce a marked prolongation in the duration of the reduction of the oxyhæmoglobin, a phenomenon which gives a new explanation of the adaptation of the human body to these heights.—On the integration of series, by M. W. H. **Young.**—On the experimental laws of sliding friction, by M. Henri **Chaumat.**—The electrotypograph and the teletypograph, by M. **de Tavernier.**—On the theory of nickel steels, by M. C. E. **Guillaume.** Nickel steels can be classified in two divisions, according as they do or do not possess a thermal hysteresis.—On the spontaneous dichroism of mixed liquids, by M. Georges **Meslin.** All liquids which possess spontaneous dichroism are also those which are the most active under the influence of the magnetic field; the reciprocal of this is also true.—On the phenomena connected with the mast in wireless telegraphy, by MM. André **Broca** and **Turchini.**—The relation between the dielectric cohesion of a gas and its temperature, by M. E. **Bouty.** For temperatures between 20° C. and 190° C., air, hydrogen and detonating gas possess a dielectric cohesion which is independent of the temperature, from which the law is deduced that the dielectric cohesion of a gas or of a mixture of gases depends only on the mean distance of the molecules.—Determination of the electrochemical equivalent of silver, by MM. **Pellat** and **Leduc.** A detailed account is given of the numerous precautions observed in this determination, the mean result being 0·011195.—On the electrolytic transport of certain ions in gelatin, by M. Aug. **Charpentier.**—The production of ozone in spirals with high tension currents of high frequency, by M. H. **Guilleminot.**—Positive accumulator plates of high capacity, by M. **Vaugeois.** Capacities of from 0·7 to 1·24 ampere-hours per square decimetre of plate have been obtained.—On recent results obtained in the treatment of arterial hypertension by d'Arsonvalisation, by M. A. **Moutier.**—A new method for putting in evidence ultra-microscopic objects, by MM. A. **Cotton** and H. **Mouton.**—On the anticipated liquefaction of oxygen from air, by M. Georges **Claude.** If air is liquefied progressively, the first portions are rich in oxygen.—Study of the mode of oxidation of manganese salts by alkaline persulphates in acid liquids, by M. H. **Baubigny.**—The preparation and properties of some new plumbic derivatives, together with their thermochemical data, by M. Albert **Colson.**—On an organic base containing phosphorus, its constitution and some of its salts, by M. P. **Lemoult.** The substance obtained by the interaction of PCl_5 and aniline has not the constitution $PCl(NH.C_6H_5)_4$ ascribed to it by Gilpin, but is more probably the hydrochloride of a new base, $(C_6H_5.NH)P.N.C_6H_5$, various salts of which are described.—The volumetric estimation of nitric nitrogen, by M. **Débourdeaux.**—On silicon amide and imide, by MM. Em. **Vigouroux** and **Hugot.** The amide is produced by the interaction of silicon tetrachloride and ammonia at temperatures below 0° C., above 0° the imide is the chief product.—Combinations of hydroferrocyanic acid with organic compounds, by MM. **Chrétien** and **Guinchant.**—The preparation of primary alcohols by means of the corresponding acids, by MM. L. **Bouveault** and G. **Blanc.** The methyl and ethyl ester of the fatty acid is reduced by sodium in the presence of absolute alcohol. Details are given for octanol.—The influence of the nature of the external medium on the formation and evolution of odoriferous compounds in plants, by MM. E. **Charabot** and A. **Hébert.**—New method for the estimation of oxalic acid in urine, food, &c., by M. **Albahary.**—On the production of glucose by animal tissues, by MM. **Cadéac** and **Maignon.**—Researches on the transversal scalariform striated bands in the cardiac fibres, by M. F. **Marceau.**—The action of carbon dioxide on the eggs of echinoderms, by M. C. **Viguier.** The theory of temporary poisoning of Delage is not true for the sea urchins; carbon dioxide is not clearly differentiated from other reagents used in experiments on artificial parthenogenesis.—On the development of the ovary of *Polyxenus lagurus*, by M. A. **Lécaillon.**—The action of emulsin on salicin and amygdalin. Theory of the action of emulsin, by MM. Victor **Henri** and S. **Lalou.** The emulsin forms an intermediate compound with the body upon which it is acting, and this is decomposed, regenerating the ferment.—On the teratological forms of *Sterigmatocystis nigra* deprived of potassium, by MM. **Molliard** and H. **Coupin.**—On *Cryptostegia madagascariensis*, by M. Henri **Jumelle.**—On a new group of fungi, the Bornetineæ, and on *Bornetina Corium* of the vine, by MM. L. **Mangin** and P. **Viala.**—On the bilateral symmetry of the rootlets of *Pontederia crassipes*, by M. **Chiffot.**—On the presence of macroscopic crystals of albite in the dolomites of the Trias of Crete, by M. L. **Cayeux.**—Observations on glacial phenomena in Corsica, by M. Paul **Castelnau.**—On the existence of two great circles of maximum seismic instability, by M. de Montessus **de Ballore.**—On a chicken which lived seven days after hatching out, with a second yolk enclosed in the abdomen, by M. Frédéric **Houssay.**—Apparatus for the inhalation of oxygen, by M. **Guglielminetti.**—The variable state of active muscles during the time of a contraction in the ergograph, by MM. A. **Imbert** and J. **Gagnière.**—Dust shower recently observed in Iceland, by M. Stanislas **Meunier.**

CONTENTS.

PAGE

THURSDAY, JULY 16, 1903.

THE UNIVERSITY IN THE MODERN STATE.

IV.

IN previous articles we have pointed out that the penuriousness of our national policy towards the Universities results in the worst form of extravagance, the waste of thought and effort through want of proper tools. Because we will not give more, even what we do give is robbed of its proper fruit. Few institutions could be found which illustrate this more clearly than the three colleges of the University of Wales, in spite of the active work which they are doing.

The earliest of their charters is barely twenty years old, and the University was only founded in 1895, yet they have within their walls some 800 matriculated students pursuing full degree courses, and, roughly speaking, as many more who are either preparing for external degrees or diplomas, like the medical students at Cardiff; or taking some university courses as a part of a professional curriculum, like most of the normal and many of the theological students at all three colleges. The total population of Wales amounts to only 1,700,000, so that a total of some 1500 students makes a proportion of nearly 9 in 10,000, as against nearly 5 in England, nearly 8 in Germany, and nearly 13 in America (see our article of May 14). This is strong evidence of the eagerness with which university education is sought in the Principality, and of the confidence felt in its colleges. And the soundness of their teaching as a whole is indicated both by the names that appear on the list of their teachers and by the successes won by their former students at older Universities and elsewhere.

What, then, is their need to-day? Why can they not continue the work they have begun?

For two reasons. First, because their achievements so far have been attained at too great a cost. The beginning of a new and promising national movement aroused among its first promoters a spirit of enthusiasm and self-sacrifice which has not, indeed, passed away, but which has been sobered by bitter lessons. Those who knew anything of the life of the late Principal Viriamu Jones know that he was literally killed by the burden of too heavy a task; and there have been several other cases of serious overstrain, though none have ended so tragically.

From facts before us it is clear that not merely the principals, but the heads of all the large departments in the colleges, feel that the difficulty of meeting the growing duties of the university without any increase in its endowments has reached an intolerable degree, that is to say, from the outsider's standpoint, it has become incompatible with real efficiency.

In the second place, the cost of university education has risen greatly since the colleges began their work. The developments in education which have taken place in cities like Liverpool and Birmingham—to mention these alone—have created a new demand for men fitted for professorial work; and conditions which twenty years ago, when the work of the colleges was lighter than it is now—and when the Civil Service drew no men from the Universities—were sufficient to attract young men of distinction, no longer seem so desirable.

Nearly all the English colleges have been steadily forced by competition to raise the terms they offer to their staff. We know of two or three instances in which stipends have been specially raised in order to secure some professor who was at the time in the service of a Welsh college.

Even from an English point of view it is clear that this implies that larger funds will have to be found if university education is to be maintained at an efficient level. But in Wales, where it is impossible to raise such funds on any adequate scale, the facts wear a more serious aspect. The colleges feel their needs in three directions, in teaching, in research, and in administration; all alike are unnaturally burdened by poverty. In regard to teaching, perhaps the worst case is that of subjects like geology, botany and economics, which in more than one college are represented only by lecturers; their remuneration varies, but is at best scarcely more than half the professorial stipend. In all the colleges, changes of staff are undesirably frequent.

It seems unkind to point out further that large branches of knowledge like chemistry and engineering, or, on the "Arts" side, English or philosophy, not to mention older subjects, have outgrown the power of any one man to teach properly. This fact has been recognised by wealthier colleges (especially in Germany and America), in which each of these subjects employs several professors.

In Wales, again, the later developments of university study, such as the different branches of commerce, are hardly represented at all.

Finally, under this head, we may observe that in no one of the colleges is there any provision for pensioning their teachers when they reach the limits of effective work, and it is clear that this will shortly become a serious question.

In research we must acknowledge how much good work has been done—the names of Principal Viriamu Jones and Prof. Gray (now of Glasgow) at once suggest themselves in the department of physics alone; and among the present members of the colleges there are men of distinction both in science and letters. But the difficulties they have had to face have always been serious, and of late years have grown greater rather than less.

For want of adequate endowments both the laboratories and the libraries have grown steadily poorer in proportion to the growing demands of study. In one of the colleges the total expenditure on the library for more than twenty subjects, including the cost of periodicals and binding, is some 150*l.* a year! Everyone knows the discouraging effect of finding that some instrument or book of which one is in pressing need is out of reach.

The long vacation, it is true, offers opportunities, but here, again, a man's powers of research are limited by financial conditions. Men who are hard at work examining through most of July and August will not produce a great deal of original work in Septem-

ber, and the administrative work of the colleges now continually intrudes even upon the long vacation. From a general point of view, however, such disabilities of members of the staff would be of less consequence if the younger members of the colleges, honours students, or graduates of promise could secure more favourable conditions. Unfortunately, it is only too obvious that where a professor's chances of conducting original work are meagre, those of his students will, as a rule, be more meagre still. And in spite of the zeal with which the University of Wales has striven to foster original research, in every subject, in the regulations for its higher degrees, it is clear that unless the colleges can be placed in a better position financially, these efforts are doomed to disappointment. In one of the colleges a recent gift of valuable, if not unique apparatus is lying unused, and must do, until funds are found to build and maintain a proper laboratory to contain it.

Thirdly, and perhaps chiefly, the colleges suffer from their present position on their administrative side.

Making bricks without straw is not merely a discouraging, but an extremely difficult operation, and in any institution which attempts it, in the long run the best wits of its staff will be those that are set to the task. The colleges are finding more and more that even their teaching day is honeycombed with business.

Nor is this all. Where money is scarce, the spending of it is apt to be attended with an amount of ceremony which is itself a burden. In one college we are told it needs a series of resolutions discussed by four or five bodies before a new charwoman can be engaged. There could not be a better illustration of the waste of time which poverty entails. All the colleges serve some eight or nine masters in the shape of outside public bodies, who maintain different classes of students, and the necessity of explaining and justifying points of educational policy to so large a number of different popular authorities is a very serious task. At every turn it is necessary to consider not merely what is the right course, but what is the best form in which to secure its adoption. That under such conditions the colleges should have been able to do anything at all is satisfactory evidence not only of the keen interest in the university which is taken generally by the public bodies of Wales, but also of the wisdom with which the colleges, especially their principals, have discharged their task. Whatever may be thought of the policy of a democratic basis for university education, it will be admitted that the burden of the arrangements ought not to fall upon those who are also responsible for the solid work of teaching. In Wales this is largely the case, and both the teaching and the policy of the colleges are likely in the end to suffer.

In the second article of this series (March 12) we saw that the great bulk of the endowments of the German universities was provided by the State, 81 per cent. of the total being so provided in Prussia, and 74 per cent. in Germany as a whole. Wales, happily or unhappily, possesses comparatively few men whose individual possessions could enable them to take part in endowing her colleges in any way commensurate with the need. Of the sums that have been raised for buildings, a great part has been collected, at the cost of healthy but disproportionate effort, from the shillings and pence of artisans and small farmers or traders. It is not surprising, therefore, to find that the colleges and the university depend already mainly upon public funds. The County Council grants to Cardiff and Aberystwyth must in fairness be counted as fees, not endowments, since they are given in return for teaching a definite class of students, and a change of policy in the local authorities might at any time modify or even divert their contributions. The figures are approximately[1] as follows, reckoning the interest on investments, as heretofore, at 2½ per cent., and including in the Government grants those devoted to special objects, such as agriculture, and the training of primary teachers.

Present Endowment of University Education in Wales.

	Income from Private Endowments.	Income from Government Grants.
	£	£
University College, Aberystwyth...	375	6000
University College, Bangor	1225	6000
University College, Cardiff	750[2]	5250
The University of Wales ...	—	4000
Totals	£2350	£21,250
Percentages	10	90

There is only one conclusion. In great cities like Liverpool and Manchester there is accumulated wealth and an accumulated tradition of culture to which their colleges have appealed with some success. In Wales the culture has been for centuries remote from university life, and the wealth, as we have seen, is non-existent. If, therefore, the Government wishes that the 21,000*l.* a year which it now spends in grants to the colleges and the University of Wales shall not be wasted, it is high time that it should face the question of what they really need.

In order to represent these needs in as concrete a form as possible, we have made inquiries as to the sums which, in the opinion of responsible persons at each college, would suffice to place them in a position to discharge their work with real efficiency. In each case we shall mention two capital sums, the one that required to construct or complete the buildings and equipment of the college, the other that required as an endowment for maintenance, the interest in this latter case being reckoned at 2½ per cent. Aberystwyth has from the first been the most fortunate of the three colleges in the matter of buildings, so that its needs under this head are smaller; similarly Bangor needs slightly less towards maintenance as being possessed of somewhat larger invested endowments, Cardiff and Aberystwyth having only very small possessions of this kind; trust-funds for scholarships are, of course, disregarded altogether in the estimate.

The figures assume that the present Government grants will continue, and under both heads state the

1 The exact figures vary slightly from year to year.
2 Including the annual grant of 350*l.* from the Drapers' Company for Engineering.

sums needed in addition to all the resources the colleges at present possess.

Funds needed for University Education in Wales.

	A. For Buildings and equipment.	B For endowment.
	£	£
University College, Aberystwyth	99,800	1,071,500
University College, Bangor... ...	176,500	960,400
University College, Cardiff... ...	162,000	1,176,400
The University of Wales	—	288,400
Totals	£438,300	£3,496,700
Grand total	£3,935,000	

In round figures, therefore, we may say that university education in Wales needs an endowment of four millions sterling to secure its efficiency. This will not be thought an extravagant figure when it is remembered that the need of the Birmingham University was estimated at five millions, and that the Welsh colleges minister to the needs of a far more diverse population. The agriculture, the manufactures, the mining and the over-sea commerce of Wales all demand the enlightenment and intelligence which can only be developed in universities efficiently equipped for their work.

FORMOSA.

The Island of Formosa. By James W. Davidson, Consul of the United States for Formosa. Pp. 646+xxviii+46. (London and New York: Macmillan and Co., Ltd., 1903.) Price 25*s.* net.

CONSUL DAVIDSON'S work on Formosa is a heavy quarto volume of 700 pages, in which the liberal use of small type indicates that its author has tried to pack as much as possible within a given space.

It is not a lap book, but a book for the study table, in which 168 photographs and other pictures give of themselves a liberal education about things Formosan. A coloured frontispiece shows Mount Morrison capped with snow, 13,880 feet in height. This, which is one of the many peaks in the mountain ranges which form the backbone of Formosa, is the highest mountain in the Japanese Empire. Another illustration is that of sea cliffs on the eastern coast. These, which attain heights of 5000 to 6000 feet, are possibly the highest sea cliffs in the world. Orographic features with these magnitudes in an island about half the size of Scotland are certainly remarkable. From other pictures, in which are depicted generals, battles, dismantled forts, Chinese temples, the surrender of the Dutch to Koxinga, the torturing of Dutch by the Chinese, Japanese streets, tea houses and barracks, a Christian church, a police station, a meteorological observatory and railways, it may be inferred that, politically and socially, Formosa has had a chequered history.

The Chinese, who have known Formosa since A.D. 608, tell us that it was created by certain fierce dragons which glided out from the gates of Foochow, and lashed up the bed of the ocean until Formosa was created. The origin of this may rest on the fact that Formosa has, at least in part, resulted from volcanic activity, and in the Eastern mind such activities and dragons were in past ages closely associated. In the early Middle Ages the harbours of this island, which are almost entirely confined to its western shores, were used as clearing houses for trade between China and Japan, and also as homes for pirates. One princely freebooter who settled and married in Japan started life as a Chinese tailor. Before he died, by raids and intrigues he commanded 3000 sail, and was so powerful that he could not be opposed even by the Emperor of vast Cathay. He became a Christian, and was christened Nicholas. His son, Koxinga, born in Japan, was more powerful than his father, and remains one of the most remarkable characters in Eastern history. In 1662 he drove the Dutch (who had supplanted the Chinese) from Formosa, established a court, promoted industries, enacted wise laws, and ruled a nation of exiles and outlaws. China was helpless against him, and but for his sudden death it seems likely that he would have driven the Spanish from the Philippines. His grandson, a weakling, allowed the "Beautiful Isle" to fall back under Chinese mismanagement, and had these original owners only taken steps to award punishment for massacres and murders of shipwrecked crews, chiefly of foreign nations, Formosa might possibly have remained part of the Celestial Empire until the present day.

In 1874, in consequence of an outrage committed on the crew of a Loochooan vessel, Japan undertook a punitive expedition against Formosan outlaws. This was the thin end of a wedge which, after the war of 1895, was driven home, and Formosa was added to the Japanese Empire. It is, however, yet far from being completely under Japanese jurisdiction. The mountainous and densely wooded centre and eastern parts of the island still safely shelter head-hunting savages, whilst the borderland of these pathless jungles is a home for outlaws, and it is particularly against the latter that the Japanese seem helpless. The difficulty is to find them. At night villages may be looted by a howling mob, but next morning the sun rises upon smiling agriculturists.

After describing the tea industry, we are entertained with a long account relating to camphor. The camphor trees are, unfortunately, within the domains of the Aborigines, with the result that the camphor industry, head-hunting and butchery still go hand in hand. The chief victims appear to be the Chinese, the Japanese being but rarely attacked. Other industries are those of sugar and the mining of coal and gold. When speaking of the sulphur deposits, which are associated with geysers and a variety of spiteful volcanic vents, Mr. Davidson tells us that, in order to prevent certain insurgents obtaining material for the manufacture of gunpowder, an Imperial edict arrived from Pekin ordering officials to destroy all sulphur deposits by fire, and to stop up all offending craterlets which produced this substance. Altogether eighty-eight volcanic orifices were discovered, on which for several years officials paid quarterly calls, and with

perseverance, hope, and clods endeavoured to stop their roarings. This was in 1833.

Long lists and descriptions are given of various plants having an economic value, amongst which we note indigo and other dye plants, fibre plants, paper plants, oil plants, tobacco, coffee, &c., together with some account of forest trees.

The description of the savages is derived from the work of Mr. Y. Ino, who devoted several years to their study. Eight groups are referred to, and for each of these an account is given of their dwellings, dress, ornaments, food, diseases, head-hunting, language, and generally on subjects of anthropological interest. All we have bearing upon zoology is a list of land birds by J. D. de la Touche, and a list of mammalia by the late Mr. Robert Swinoe, the latter, unfortunately, only bringing us up to 1872. Meteorology and seismology are referred to in a short appendix, but about geology Mr. Davidson is practically silent.

With this and a few other exceptions the work is encyclopædic in its character, and it may well be recommended to commercial and scientific men who search for information about the island of Formosa.

THE BASIS OF PLANT-SURGERY.

Pathologische Pflanzenanatomie. By Dr. Ernst Küster. Pp. 300, and index. (Jena: G. Fischer, 1903.) Price 8 marks.

THAT plants have their diseases is a truth that has forced itself more and more on this colonial empire of ours, and that the signs of disease frequently express themselves in abnormal structures and outgrowths is well known to those few experts who have to deal with the galls, cankers, pustules, tumours, and other "malignant" tissue-formations, the very names of which remind us of the ills to which flesh is heir.

Moreover, there is a surgery of plants, as well as of animals, and the true basis of this growing art is in both cases a thorough understanding of the pathological, or diseased, as well as of the normal or healthy anatomy of the patient.

This scientific basis of a refined art is the subject of the work before us.

The author of this treatise had already distinguished himself in Münich by his work on the anatomy of galls, and it is with the greatest satisfaction that we find him inaugurating his career at Halle by a thorough exploration of what is to a large extent a practically new theme, and one, moreover, so worthy of the traditions of his present post, for it is remarkable that, while we have several modern books on physiological anatomy and on the pathology of plants, no competent botanist has given us a detailed and comprehensive treatise on this now important and rapidly extending subject.

Küster's book consists of 300 pp. of excellent and clearly-written matter, illustrated by 121 figures not always worthy of his text, though never obscure or irrelevant.

He divides his subject into six chapters, of which five are devoted to technical and special descriptive anatomy as modified from the normal by pathological changes in the life-work of the tissues and cells, while the sixth is told off to do duty as a general account of the pathological processes themselves, and of what little theory we as yet possess on the subject.

Much as we admire the collection of anatomical facts, and the descriptions of morbid anatomy in special cases, comprised in these first five chapters, it must be evident that the subdivisions are somewhat unfortunate. The author himself apparently sees this, as is evinced by the uncertainty as to which heading certain cases shall be placed under, and we believe that the shortcomings are partly due to a somewhat slavish following of the terminology of the animal pathologists.

These headings are:—I. *Restitution,* under which are placed cases in which changes in growth, induced by sections and wounds, lead to the new formation of the cut-off parts, or to proliferations of various kinds.

II. *Hypoplasie,* or arrested development of organs or parts due to various inhibiting reactions, which bring about diminutions in the number or sizes of cells, or otherwise change the tissues so that they stop short of a stage of development which would normally be regarded as complete.

III. *Metaplasie,* or progressive changes due to overstimulations which result in the cells and tissues undergoing structural changes in excess of the normal, though not suffering the enlargements or increase in numbers dealt with under the next and the fifth heading.

IV. *Hypertrophie,* where the cells attain dimensions more or less inordinate, and due to excessive growth while young and turgid. Most galls—in the widest sense—afford examples of these cases, which are extremely common.

V. *Hyperplasie,* or those abnormalities—usually enlargements and distortions—which owe their origin to inordinate increase in the average numbers of cells.

It is, of course, impossible to discuss examples of these various cases of abnormal anatomy here, and we have already expressed our satisfaction with the general subject-matter. We may note in passing that while Miss Dale's beautiful work on "Intumescences" is properly acknowledged, and one of her excellent illustrations suitably used on p. 86, the best results of her ingenious experiments on the kind of light which induces these abnormalities are not adequately given or apparently apprehended in the summary on p. 87.

To most readers, however, it will be the subject-matter of chapter vi. which will prove most attractive, though there is disappointment in store for anyone who expects anything beyond the most sketchy survey of the factors concerned in ætiology and development and their bearing on pathology. The sections on stimuli and reactions seem to us particularly weak, and the conclusion that any tissue can give rise to any tissue element—"aus jeden Gewebe kann alles werden"—may appear too lightly arrived at unless the reader is acquainted with the somewhat voluminous literature. The same, perhaps, applies to Küster's conclusion that tissue-elements quite foreign to the

species may arise in a pathological structure, though in our opinion he establishes his contention.

The book is undoubtedly a stirring contribution to botanical science, and ought to stimulate research in many directions, and although it escapes the responsibilities of being a great work, it is certainly one that must be on the shelves of every investigator of first rank who has anything to do with the anatomy or pathology of plants. We cordially welcome this interesting book as a pioneer work of what will grow to be an immense subject.

COMETS AND THEIR TAILS.

Comets and their Tails, and the Gegenschein Light. By Frederick G. Shaw. Pp. 70. (London: Baillière, Tindall, and Cox, 1903.)

THE theory of comet's tails has not yet arrived at its ultimate destiny, which we suppose is that of becoming an orthodox branch of applied mathematics; and consequently it still possesses a fascination for the world at large. True, the phenomena have been discussed by Prof. Bredichin, in a succession of papers that now go back nearly thirty years; but the origin of the forces required for Bredichin's theory is very obscure, and the net result is to excite rather than to remove conjecture. During the last few years the general mental ferment over the new views of the constitution of matter has given a fresh stimulus to speculators in this part of astronomy, and a considerable literature has already gathered round the suggestions of J. J. Thomson, Arrhenius and Deslandres.

Mr. Shaw, whose book now lies before us, is not a follower of any of these schools; he holds that the comet's tail is caused by the rays of the sun being altered (by concentration and refraction) by their passage through the cometic atmosphere, and thus rendered more capable of being reflected from the meteoric matter in the neighbourhood. In other words, the tail does not really exist; it is merely a local illumination of the general circumambient dust of space. The idea bears some resemblance to the now frequently accepted explanation of the lighting-up of the Nova Persei nebula.

After stating this theory, and offering a general justification, the author proceeds to examine the records of the great comet of 1858 in the light of it. For this purpose he uses G. P. Bond's monograph to a considerable extent, a mistake which occurs in the first plate of the Harvard astronomer's account being unfortunately twice reproduced; the point chiefly dwelt on is the sympathy between the phenomena of the nucleus and those of the tail.

The work as a whole is brief, its tone is very modest, and it is not claimed that the theory has been worked out in detail. It is therefore scarcely fair to blame the author for the difficulty which one finds in attempting to explain by causes of this kind the singularly complex character of cometary appendages. But any theory of the kind must offer some explanation of their most constant and remarkable features, such as the multiplicity of tails, their curvature, and the "broken" appearances often seen; and it may be doubted whether the author's theory in its present state is capable of meeting these demands. "So-called secondary tails, &c.," he accounts for "by irregular ebullitions of gas from the comet," presumably giving rise to special fields of refracted rays.

But at the root of the whole matter lies the question of whether refraction in the cometic envelope is likely to take place at all on a scale comparable with that required by Mr. Shaw's hypothesis, and at present observation seems to negative this possibility.

The latter part of the book is devoted to the Gegenschein, for which a similar explanation is given—the refraction being in this case produced by the earth's atmosphere, and the phenomenon being due to the reflection of this refracted light from meteoric dust. An interesting criticism of Barnard's views is given.

OUR BOOK SHELF.

Physical Chemistry for Physicians and Biologists. By Ernst Cohen. Authorised Translation from the German by M. H. Fischer. Pp. ix+343. (New York: Henry Holt and Co., 1903.)

PHYSIOLOGISTS and pharmacologists have from the first been ready to adopt and apply the recent theories of physical chemistry. Indeed, the eagerness with which these theories have been received by biologists has frequently led to their misapplication, inasmuch as the conditions existing in the animal organism are so widely different from those for which the theories were developed, that direct adoption of purely physicochemical results is in nine cases out of ten inadmissible. In the book before us we have a series of seventeen lectures delivered by an energetic worker in pure physical chemistry to an audience of physicians. The physicochemical principles bearing on biological problems are expounded, the chief methods of experiment adequately described, and, what is of most importance, a critical account is given of many of their applications. These applications include, for example, disinfection in the light of the theory of electrolytic dissociation, the pharmacology of complex mercury salts and of uric acid solvents from the same point of view, the taste of dilute solutions, osmotic analysis, and the toxicity of electrolytic solutions. The book is admirably adapted to its purpose, and may be heartily recommended.

Trapper "Jim." By Edwyn Sandys. Pp. ix+441; illustrated. (New York and London: Macmillan and Co., Ltd., 1903.) Price 6s. net.

ALTHOUGH, as indicated by its title, this admirable little volume is devoted rather to sport and trapping than to natural history, yet it contains scattered through its pages such excellent descriptions of the wild life of the United States that the naturalist cannot fail to find much valuable information with regard to the habits of many of the mammals and birds mentioned. Specially interesting are the notes on the various species of American hares, and it will come as a revelation to many that the so-called "jack-rabbit" (*Lepus callotis*) is probably the fleetest member of all its tribe. Many references are made to the need for the cultivation of a true sporting instinct among hunters; that is to say, to the enjoyment of the sport itself, as distinct from making a "big bag." The name of Mr. Sandys is too well known as a writer on the sport and popular natural history of North America to stand in need of any commendation on our part, but we may safely say that his popularity will certainly be enhanced by his latest effort. R. L.

Das Gesetz der Translation des Wassers. Von T. Christen, Oberförster. Pp. viii + 179; with one lithographed plate. (Leipzig: Wilhelm Engelmann; London: Williams and Norgate, 1903.)

MUCH has been written about the flow of water in pipes, channels, and rivers, considered from the point of view of the hydraulic engineer, and many attempts have been made to obtain empirical formulæ for purposes of numerical calculation. In this volume the author proposes the formula $v=k\sqrt[3]{(QI)}/\sqrt[4]{B}$, where v is the mean velocity, Q the total flow per second, I the gradient as a sine, and B the half-breadth of the channel. A comparison of the results of the author's formulæ is made, both with the results of experiment and with those of other writers, especially Bazin, and calculations are given of the velocity curves for different sections and under different conditions. Reynolds's critical velocities are also discussed. The book contains a bibliography, tables of coefficients, and a diagram of the author's experiments and of velocity curves.

The new laws are admittedly only empirical, and the author indicates that many points might with advantage be discussed at greater length, but he has certainly succeeded in including a large amount of important and suggestive information in a book of small compass, and his theories will be read and discussed with the greatest interest by hydraulic engineers and experimenters who have worked in the subject.

Colloquies of Common People. By James Anstie, K.C. Pp. 530. (London: Smith, Elder and Co., 1902.)

THE English language contains few good specimens of the philosophical dialogue, perhaps none except the masterpieces of Berkeley. In attempting to revive this most difficult form of composition Mr. Anstie has ventured on a daring task, and I fear cannot be said to have achieved a great success. Like others before him, he forgets that a dialogue is intolerable unless its author is dramatist enough to confer individual character on the interlocutors; nothing is heavier reading than wedges of disquisition by mere puppets. Of the variety of topics handled by Mr. Anstie's puppets it is impossible to give any summary, as they appear to begin their discussion anywhere and to argue anyhow. They seem, however, in the course of his five hundred odd pages to touch on most of the current topics of ethics and psychology. The reader should at least have been assisted to follow their excursions by a table of contents and an index. A. E. T.

A Country Reader. II. By H. B. M. Buchanan, B.A. (Cantab.). Pp. viii+233; with illustrations. (London: Macmillan and Co., Ltd., 1903.) Price 1*s.* 6*d.*

As Mr. Buchanan says, a child is much more likely to learn to read fluently and with intelligence if his reading book is concerned with subjects falling within his everyday experience, and from this point of view the set of readers, of which this is the second, will prove useful and popular in rural primary schools. The various sections of the book deal in simple, interesting language with the characters and uses of the goat, the donkey, the cat, our common reptiles, the fish of our ponds and streams, pastures and grasses. The illustrations are numerous and exceptionally good, though it is a pity the author has omitted to indicate the scale of the drawings; there is some fear, for instance, that quite a wrong idea of the relative sizes of the carp and minnow will be obtained by the pupil from the pictures which face one another on pp. 96 and 97.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Gases Occluded by Radium Bromide.

RUTHERFORD AND SODDY (*Phil. Mag.*, 1902, p. 582; 1903, p. 453 and 579) pointed out that the almost invariable presence of helium in minerals containing uranium indicated that that gas might be one of the ultimate products of the disintegration of the radio-elements. Rutherford, moreover, determined the mass of the projected particle which constitutes the "α-ray" of radium (*Phil. Mag.*, 1903, p. 177) to be approximately twice as great as that of the hydrogen atom, an observation which points in the same direction. These α-particles are readily absorbed by solids, and should accumulate in the solid salts of radium and in the radio-active minerals.

We have been engaged for some months in examining the spectrum of the "radio-active emanation" from radium, and during this work the opportunity presented itself of examining the gases occluded by 20 mgrs. of radium bromide which had been kept for some time in the solid state. These gases, which are continuously generated, have already been partially examined by their discoverer, Giesel, and by Bodländer (*Ber. deutsch. chem. Ges.*, 36. p. 347), and found to consist mainly of hydrogen and some oxygen. We have found that after removing hydrogen and oxygen from the gases evolved from 20 mgrs. of radium bromide, the spectrum showed the presence of carbon dioxide. On freezing out the carbon dioxide, and with it, a large proportion of the radium "emanation," the residue gave unmistakably the D_3 line of helium. This was confirmed by sealing off the tube, and comparing its spectrum with that of a helium tube. The coincidence of the two lines may be taken to be at least within 1/10th of the distance between D_1 and D_2, or say 0.5 of an Ångström unit.

This observation, if confirmed, substantiates the theory already mentioned, and brings ordinary methods to bear on the changes occurring in radio-active bodies.

WILLIAM RAMSAY.
July 10. FREDERICK SODDY.

P.S. (July 13).—We have repeated the experiment with 30 mgrs. of fresh radium bromide, kindly placed at our disposal by Prof. Rutherford, which had probably been kept for several months in the solid state. Entirely new apparatus was constructed for the purpose, and better precautions were taken to exclude from the spectrum tube carbon dioxide and the emanation. The spectrum was practically that of pure helium, with the addition of two new lines. The lines identified are:—

Red	6677	Green-blue ..	4932
Yellow (D_3) ...	5876	Blue	4713
Green	5016	Violet	4472

The additional lines are one in the red and one in the green; these we have been unable to identify.

The Extirpation of Culex at Ismailia.

I BEG to enclose for publication the translation of a report received from the general secretary of the Suez Canal Company regarding the effects of the anti-malaria campaign at Ismailia since the visit of Sir William MacGregor and myself last September. While it is obviously too early to speak definitely regarding the result on the malaria rate, the secretary is able to announce that mosquitoes of the genus Culex "ont été supprimés d'une mannière presque

absolue." Under the term Culex, I think he means to include also gnats of the genus Stegomyia.

I have received confirmatory evidence from a gentleman in Egypt, who says that he was recently able to sleep at Ismailia without mosquito nets.

The campaign against Culex at Ismailia originally promised to be a difficult one, owing to the large number of sewage-cisterns under the houses, and the result shows how easily a simple and obvious idea like that of diminishing mosquitoes by dealing with their breeding places can be acted upon by an intelligent and effective executive which sets to work at once, instead of wasting time on useless discussions—as, for the most part, we have been doing in British possessions during the last four years.

It is to be hoped that, following the work of Gorgas at Havana, and Logan Taylor at Freetown, the result at Ismailia will be accepted as clinching the proof of the fact that Culex, at least, may be materially diminished in tropical towns. RONALD ROSS.

Liverpool, July 11.

TRANSLATION of letter, dated July 2, from M. le Secrétaire général de la Compagnie universelle du Canal maritime de Suez, Paris, to Major Ronald Ross, Liverpool School of Tropical Medicine:—

"Sir,—I have the honour to inform you that, following your mission of last September, numerous works of drainage and filling up of ditches have been effected, and that a permanent department has been created for the purpose of oiling cisterns and pits and suppressing marshes and pools of water amongst the habitations of Ismailia. Moreover, measures of prophylaxis, consisting of the gratuitous distribution of quinine and arsenic, commenced in the month of April, 1902, are continued without interruption.

"Since last December, the number of cases of fever has very sensibly diminished by comparison with previous months and with the corresponding period of last year, and this decrease is maintained until to-day.

"Owing to the time at which the sanitary works were undertaken, the complete disappearance of the Anopheles is not yet realised, but it can be stated that recently captured insects have not been infected—which can perhaps be attributed to the fact that the number of cases of fever have been considerably reduced.

"On the other hand, it is interesting to note that, thanks to methodical *pétrolage*, and to the incessant surveillance of the breeding-places of mosquito larvæ, the mosquitoes called Culex have been suppressed in a manner almost absolute, and that, in the hottest period of the year, it has been possible to abandon the use of mosquito nets.

"Regarding the consequence of these measures, a definite statement cannot be made until after August to November next, the principal malaria season. We have every ground for hoping that the efforts with which you have been so usefully associated will end in the complete extinction of malaria in the town of Ismailia, and we will communicate with you when we receive definite information on this interesting subject."

Another White Spot on Saturn.

ON July 9, at 14h. 4m., I observed another large white spot in the northern hemisphere of Saturn, and on the central meridian of the planet. The spot was quite bright in contrast with the dark belt adjoining it, and a tolerably easy object. I saw the spot again on July 12, when it shone with a bright pearl-like aspect, and was estimated on the central meridian at 12h. 50m. The marking is much distended in longitude, and this makes it rather difficult to note its central passages accurately, but the motion of the object seems decidedly swifter than the rate usually adopted for the rotation period of Saturn.

The following end of a bright extension on the eastern side of the spot was on C.M. at 13h. 35s. on July 12, and a dusky patch between the N equatorial belt and the polar shading followed at 14h. 1m.

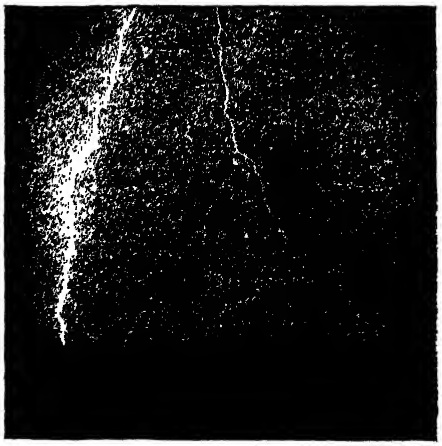
The markings above alluded to are quite different from the bright spot seen by Barnard on June 23, and by myself on July 1. The present disturbance on Saturn seems to have affected a very large area, and I have never observed anything of the same conspicuous character on the planet in past years. W. F. DENNING.

Bishopston, Bristol.

The Thunderstorm of May 31.

MR. C. H. HAWKINS, of Croydon, has sent me a copy of a photograph of a lightning flash taken by him at "Addiscombe," Croydon, on Whitsunday morning, May 31, at 2.30 a.m.

The upper part of the main flash and the side flash both show reduplication, and the photograph exhibits so many



Lightning discharge photographed at Addiscombe, Croydon, on May 31, at 2.30 a.m. Direction N.N.W.

characteristic features that its reproduction may be of service for comparison with other photographs.

I therefore enclose a copy with Mr. Hawkins's permission.

Meteorological Office, S.W., July 7. W. N. SHAW.

THE LODGE-MUIRHEAD SYSTEM OF WIRELESS TELEGRAPHY.

THE system of wireless telegraphy which Sir Oliver Lodge and Dr. A. Muirhead have been developing for some years has, within the past few months, been brought to a degree of perfection which justifies the inventors in the belief that it is now of practical commercial value. Thanks to the courtesy of Messrs. Muirhead and Co., we have had an opportunity of seeing the system at work at a small experimental installation which has been put up in a field adjoining Messrs. Muirhead's works at Elmers End, Kent. At this station signals were being transmitted to and received from a similar installation at Downe. The distance between the two stations is only six or seven miles, but the chalky nature of the Kentish soil and the fact that the station at Elmers End lies in a hollow make this distance equivalent to eight or nine times as much over water. Experiments which have been made under the conditions which would obtain in the practical application of the system for maritime work and also over the Admiralty sixty-mile range have shown that, with the same power and the same adjustments as are required between Elmers End and Downe, thoroughly satisfactory communication can be maintained across sixty miles of ocean. Considerations of distance are, however, of secondary importance in estimating the merits of wireless telegraphy systems, for the recent work of Mr. Marconi and others has made it clear enough that, given sufficient power, almost any range can be attained. Trustworthiness, clearness, the design of circuits and apparatus, and the possibility of successful syntonisation are factors of greater importance. Looked at from this point of view, the Lodge-Muirhead system presents several novel and interesting features which show that, though it may be one of the latest to come into the field of practical wireless telegraphy, it is likely to prove one

of the most efficient. Most noteworthy feature of all is the remarkably delicate coherer which has been finally evolved from numerous experiments, a coherer which not only promises to be accurate and trustworthy in practical work, but also possesses several advantages from an experimental point of view, a characteristic of no small importance in a piece of apparatus which has to be employed in an art in which there is so much to be learnt.

In general outline the Lodge-Muirhead system does not differ materially from other wireless telegraph systems, a fact which is not remarkable when it is recalled how much other systems owe to the pioneering work which Sir Oliver Lodge has carried on ever since the earliest days of Hertzian waves. In fact, if we retrace the development of Hertzian telegraphy from Maxwell's theory of light, the name of Sir Oliver Lodge is singularly prominent, and must be associated with all the more important advances. The connection begins in 1888, when he read a paper on the velocity of electromagnetic waves along wires at the meeting of the British Association, at which Prof. Fitzgerald directed attention to the work that Hertz had accomplished; a little later he discovered, in its simplest form, coherer action, and it is interesting to note that after long trial of the filings coherers derived from the discoveries of Branly, there seems to be a tendency on all sides to return to simpler designs much more closely resembling Lodge's original single contact coherer. To Lodge also belongs the credit of having been the first to insist upon the importance of tuning, and of having pointed out how this might be possibly attained by the proper use of self-induction and capacity. Moreover, it was, we believe, he who suggested using a transformer in the aërial circuit at both transmitting and sending stations instead of connecting the spark gap or coherer direct to the aërial; this device is now in general use for tuned systems. It will readily be realised, therefore, that a system which has been designed by Sir Oliver Lodge is likely to be one of the most promising of wireless telegraph systems, and that this is all the more likely to be the case in the present instance, as Sir Oliver has had the cooperation of Dr. Muirhead.

We do not propose to give a general description of the system, for, as we have said, other systems are similar in general outline, and with these most people are by now familiar. In the installation working between Elmers End and Downe there is no earth connection. The precise utility of an earth connection has been often in dispute, most people maintaining that it merely serves to introduce the earth as the second plate in a large condenser, the first plate being represented by the aërial wire and any capacity connected to it. In the system under consideration, a second capacity is provided which lies upon but is insulated from the earth; in the Elmers End station the capacity was beneath the floor of the instrument shed, and was connected to one terminal of the spark gap (or transformer), the other terminal being connected to the aërial, which has an open wire cage serving as a suitable capacity at its upper end. We need not enter here into the various ways in which the circuits can be connected up; the relative positions of coherer, spark gap, capacity and self-induction, the employment or not of the transformer, &c., offer a number of solutions to the problem of designing a complete station each of which has its special merits for particular purposes. In principle, all result in the same thing—a very large Hertz radiator transmitting into space a succession of untuned or carefully tuned electromagnetic waves. The two questions of primal importance are how to produce those waves, and how to detect them at the receiving end.

FIG. 1.—Complete Lodge-Muirhead Apparatus.
From left to right as follows:—Battery, receiver, spark gap, induction coil, signalling key, buzzer (at the back), automatic transmitter, and perforator.

The production of the Hertzian waves presents several difficulties. Even for moderate ranges of transmission fairly powerful sparks have to be used; these are obtained from a special induction coil and spark gap (Fig. 1). Here again one notices in the simple spark gap between two rods a return to less complicated apparatus; in the early days of wireless telegraphy a spark gap between polished balls in oil or vaseline used to be regarded almost as essential. In using this apparatus for syntonic work a very great deal depends upon the spark. It is necessary, in the first place, to obtain a regular succession of sparks for every depression of the signalling key. The ordinary forms of make-and-break used with induction coils have not been found satisfactory, and a special form of interrupter or "buzzer," as it is called, has been designed. This is seen at the back on the right of Fig. 1. It consists of an ordinary mercury break operated by two cross-connected telegraphic sounders. The first of these sounders works in the same manner as an ordinary electric bell, the arm vibrating to and fro when the signalling key is de-

pressed and the circuit closed; the vibrating arm opens and closes the circuit of the second sounder, to which is attached the dipping rod of the mercury break. It is said that this arrangement gives a more regular succession of sparks than is obtained with one sounder only. An automatic transmitting apparatus has also been worked out by Messrs. Lodge and Muirhead. This is shown at the right of Fig. 1, in front of the buzzer, and consists of two pieces of apparatus, a perforator and a transmitter, which are used in conjunction with the buzzer, &c., in place of the ordinary signalling key.

A regular succession of sparks having been thus obtained, still only part, and that the simpler part, of the difficulty has been overcome, for it is not the period of the sparks but the period of the oscillations in the spark which has to be syntonised. When one considers how short is the train of waves from each individual spark and how long comparatively the interval between two successive sparks, it is easy to see the importance of getting the best results possible

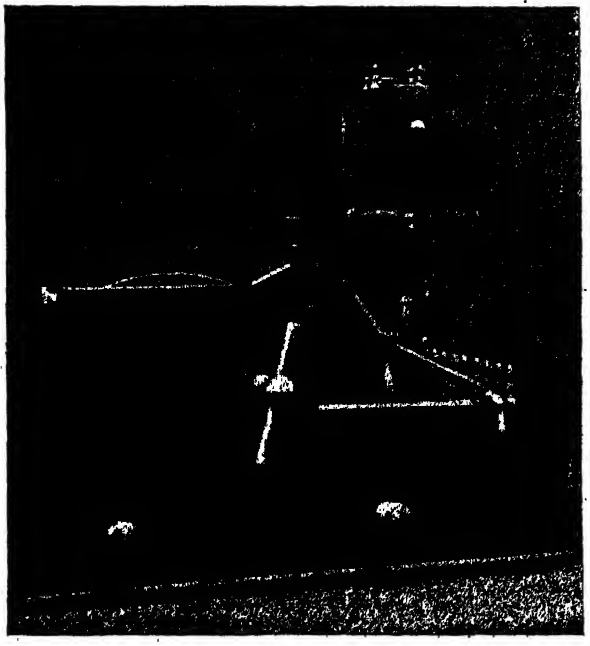


FIG. 2.—Receiving Apparatus.

from each spark. Herein, indeed, seems to lie one of the chief unsolved problems of wireless telegraphy—the problem of obtaining a really continuous series of undamped oscillations. It seems doubtful whether, even with the best possible design and arrangement of apparatus, a satisfactory solution will ever be found by means of disruptive sparks. Perhaps we must look to some quite different method of setting up the oscillations. The method that gives most promise of ultimate success is some application of the principle of Mr. Duddell's musical arc, as suggested by Mr. Duddell at the Royal Institution last year (see also the *Electrician*, May 1, vol. li. p. 84). It certainly seems that from this discovery may be developed a means of producing a continuous series of undamped oscillations of high frequency, and if this should prove to be possible a change amounting almost to a revolution would be effected in the practice of syntonic wireless telegraphy.

We may pass now to a consideration of the receiving instruments which are shown in Fig. 1, and in more detail in Figs. 2 and 3. Fig. 2 represents the complete receiving instrument. The instrument looks at first sight much like a Morse recorder; the coherer is mounted behind the box which contains the clockwork for feeding forward the tape and rotating the coherer wheel. Its construction can be seen from Fig. 3, which shows a coherer by itself. It consists of a small steel disc with a fine razor edge which dips into a little pool of mercury in an ebonite cup. The mercury is covered by a thin film of oil, and the disc is adjusted so that under normal conditions the oil serves just to insulate it from the mercury. When oscillations are set up in the coherer circuit, this thin layer of insulation is broken down, and connection established between the disc and the mercury. The disc is slowly rotated by means of the notched wheel seen clearly in the illustration, which gears with a similar wheel at the back of the clockwork box. Connection is thus no sooner established between the disc and mercury than it is broken again by a fresh oily portion of the edge coming round; there is consequently only connection during the time the oscillations are actually arriving and the

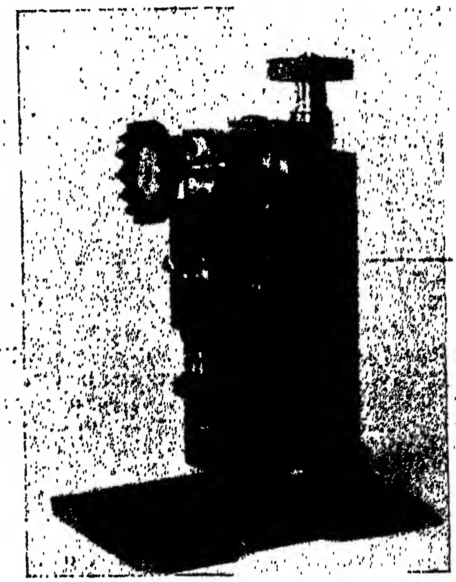


FIG. 3.—The Coherer.

coherer is self-decohering and requires no tapping back. In some respects the device recalls a suggestion made by Rupp five or six years ago, who proposed mounting a filings coherer so that it was rotated slowly by the Morse tape. The Lodge coherer is, however, a far more mechanical contrivance than a filings tube however the latter may be decohered. In order to keep the edge of the disc clean a pad of felt is pressed lightly against it; this can just be seen on the left near the top of the disc; contact is made by a spring pressing against the shaft on which the disc is mounted. The coherer will only work with a very small potential difference—a fraction of a volt—between mercury and disc; it is therefore connected in series with a potentiometer, which reduces the voltage from the cell.

Another feature of the receiving circuit is the absence of any relay; the coherer and potentiometer are directly in series with the recording instrument, which takes the form of a simple syphon recorder. This is seen on the right of the clockwork in Fig. 2; the pen consists of a fine glass syphon tube suspended from the galvanometer coil, one end dipping in a cup of ink

and the other resting on the tape. When no signals are being received the pen draws a fine line on the paper, but when a signal arrives it is deflected. The result can be seen from the specimen of tape in Fig 4. There is an arrangement by which the amplitude of the deflection can be controlled by making the syphon come up against a stop. It is obvious that the tops of the humps in the line representing dots and dashes are not needed for reading the message, since it is easy to see from the length of the break in the base line whether the signal is a dot or a dash. The tops of these humps have, however, a special interest. It will be noticed, on examining them closely, that they are not smooth, but are slightly irregular. These irregularities represent the sparks, and it is possible therefore to see from the form of the humps whether the sparking at the transmitting end is good or bad. A particularly bad spark is seen at the beginning of the third signal (the second dot) in the letter *l*, and a careful examination, of the dashes more especially, shows quite clearly the nature of the sparking at the transmitting station seven miles off. This not only points to the great sensitiveness of the coherer, but shows that it should prove particularly useful in research, since by its use one can obviously much better investigate the conditions necessary for good signalling. In spite of this delicacy, it is remarkable how easy the coherer is to adjust. A milled head screw allows the mercury to be raised or lowered at will, and it is quite easy to get proper adjustment in a few seconds, even though one starts with the disc either in permanent contact or right out of contact with the mercury; in fact, the whole coherer can be dismantled and set up again in a few minutes. This coherer seems to us one of the most promising features of the system; it is a device at once quite simple and thoroughly mechanical, easy to reproduce, and easy to adjust, and, judging by the results which have been obtained, is both sensitive and trustworthy in practical work. So far as one can judge without lengthy experiment, it is more promising than any other form of receiving apparatus yet devised.

We may add that the system has been adopted by the Eastern Extension Telegraph Company on its two new cable ships, and is reported to be giving every satisfaction. In conclusion, we should like to express thanks to Messrs. Muirhead and Co. for showing us the system at work, and for lending the photographs from which the illustrations to this article have been made.

MAURICE SOLOMON.

FIG. 4.—Facsimile of Tape.

THE ALLIED COLONIAL UNIVERSITIES CONFERENCE.

A STRONG committee—Sir Gilbert Parker being the moving spirit—addressed the following circular letter to the universities of the United Kingdom on May 30:—

In order to facilitate the proceedings at the Allied Colonial Universities Conference, to be held at Burlington House on July 9, I shall be very much obliged if you can assist me with information upon the following points:—

(*a*) Whether, and if so in what way, the conditions under which degrees are given by the University of —— are modified in the case of persons who have studied in or taken the degrees of colonial universities.

(*b*) Does the University of —— afford any special facilities for post-graduate study (in particular with regard to applied science) to the graduates of colonial universities? Does the university reward special post-graduate students by bestowing upon them degrees, and on what conditions as to residence or tests of fitness are such degrees bestowed?

(*c*) Does the University of —— possess any special endowments for the encouragement of colonial students; or are colonial students habitually aided by any endowments not under the control of the university?

(*d*) What is the average number of colonial students studying in the University of ——?

The colonial universities (with the exception of the universities of India) had meanwhile been asked to appoint delegates to represent them at the conference, with the result that, when the conference opened, almost every university within the Empire was directly represented.

The actual session occupied one day only, but a good deal of hospitality was exhibited during the week, and whatever view may be held as to the value of the business actually transacted, there can be no question as to the quality of the entertainment provided. The informal meetings between the delegates, both before and after the session day, constituted probably the most important part of the conference; the opportunity for interchange of ideas was absolutely unparalleled in the history of British education, for not only were the delegates drawn from practically every university within the Empire, but they were, on the whole, exceptionally well qualified for their duties. It is not possible to set down in writing a precise estimate of the advantage to be drawn from informal conversations between those who are interested in the same things but have few opportunities of discussing them; the British Association, however, affords a proof, repeated annually, that there is a very important advantage to be gained in this way. Those engaged in carrying on university work in new countries and in communities where the importance of that work is not always properly understood, are apt to wonder now and again whether they are really on the right track, whether their work is, after all, as important as they have been in the habit of thinking it is, and whether their methods are sound and progressive. To such men the stimulus of a conference such as the one just over is invaluable, and the chance of learning at first hand what others are doing is also invaluable.

To come to the conference itself. The chairman, Mr. Bryce, called the meeting to order with commendable punctuality, and explained in a scholarly way—though in the most general terms—how universities might cooperate to their mutual advantage. The Vice-Chancellor of Cambridge then proposed the first resolution:—

"That in the opinion of this conference it is desirable that such relations should be established between the principal teaching universities of the Empire as will secure that special or local advantages for study, and in particular for post-graduate study and research, be made as accessible as possible to students from all parts of the King's dominions."

This was supported with businesslike brevity by various delegates both from the United Kingdom and from Greater Britain, and was finally passed without dissent. From the discussion the following principles finally emerged:—

(1) There must be no thought of attempting uniformity of regulation—each university must decide for itself how it should treat post-graduate students from other universities.

(2) The question at issue was, for practical purposes, to be limited in the first instance to the consideration of post-graduate facilities. In this connection it was shown by Sir Henry Roscoe that the scholarship system of the Commissioners of the 1851 Exhibition had proved itself to be a great success, and Prof. Ewing showed that the Cambridge "research tripos" had also succeeded beyond all expectation.

Cambridge appears to be the only university which, so far, has provided satisfactory machinery for post-graduate students of other universities, and one of the objects of the conference was to induce other universities to show themselves as liberal as Cambridge in this respect.

(3) It appeared that more scholarships on the lines of the Commissioners of the 1851 Exhibition were needed, and could be worthily allotted.

(4) The magnificent hospitality of the University of France and of the universities of Germany at present attract a large number of British students. It was felt that, though this might be regretted on sentimental grounds, the only legitimate manner of dealing with it was to provide within the King's dominions at least as great freedom and facility for study as could be obtained abroad.

It was abundantly clear that the delegates, as a whole, were extremely well informed on educational subjects. For instance, it was practically taken for granted by all the speakers that there can be no serious education which does not embrace a certain amount of research work; the only speaker who did not appear to endorse this view being Prof. Mahaffy, of Dublin, who was witty on the subject in the well-known mid-Victorian manner. Since Germany has given to our disadvantage a definite experimental proof of the success of research as an instrument of education, the delegates probably felt that the matter had gone beyond the range of academic discussion.

It was also interesting to note that the principle of "examination by the teacher" appeared to be fully admitted on all hands.

The afternoon session was devoted to a quite similar discussion on a motion for the appointment of a standing committee. The committee so proposed did not explain in any way what steps it intended to take, nor did any speaker ask it to do so, or make any very distinct suggestion as to its duties, so that future developments must depend entirely on personal initiative within the committee. It would have been better, probably, had the committee been less reticent.

On the whole the conference must be regarded as having met with a quite unanticipated measure of success. There was an enthusiasm and go about it throughout which was most stimulating, and of the best possible augury for the future of English-speaking university education. If secondary education could be brought up to a corresponding standard, we should be much better off than we are.

The proceedings culminated in a huge dinner of about 500 people at the Hotel Cecil on the evening of July 10, with Mr. Balfour in the chair, and at his best in proposing the toast of the evening afterwards.

The conference was excellently managed throughout, and it is fair to say that a good deal of the success attained must be attributed to the exertions of the honorary secretary, Mr. Kinloch Cooke. A conference for which no precedent exists requires, in the words of Lord Palmerston, "a lot of bottle-holding," and Mr. Kinloch Cooke appeared to be equal to all the demands made upon him.

R. T.

MR. BALFOUR ON ACADEMIC AND SCIENTIFIC EDUCATION.

We reprint from the *Times* of July 11 the report of the speech made by Mr. Balfour in proposing the toast of the evening, "The Universities of the King's Over-Sea Dominions" at the Allied Colonial Universities' dinner on Friday last:—

We are here, if I may venture to say so, a remarkable gathering in the individual capacity of the members who compose it. But I think we are still more remarkable taken in connection with the central idea which has brought us together. It is not merely, or simply, or chiefly that there are in this room the representatives of scholarship and science, of all the great spheres of activity in which modern thought is indulging itself. It is that we are here representing what will turn out to be, I believe, a great alliance of the greatest educational instruments in the Empire—an alliance of all the universities that, in an increasing measure, are feeling their responsibilities, not merely for training the youth which is destined to carry on all the traditions of the British Empire, but also to further those great interests of knowledge, scientific research, and culture without which no Empire, however materially magnificent, can really say that it is doing its share in the progress of the world. I think that we who in this room belong to the old country, and who were educated in the older universities of England, of Scotland, or of Ireland, have great reason to be proud of those who may be described as our educational children—I mean the universities of the other portions of the Empire.

We boast of community of blood, of language, of law, of literature; but surely we may also boast, and with not less reason, that the ideals of education which are working a great work in the old country are now doing their work among its younger children, and are carrying on in all the self-governing nations of the Empire work like that which they perform in the parent country. Now, my lords and gentlemen, I have mentioned two subjects already in the few sentences I have uttered which, each separately, has been exercising the minds, at all events, of people on this side of the Atlantic—the ideals of education and the ideals of Empire. We have been quarrelling—it would, perhaps, not be too much to say we are still quarrelling—over both. I ask you to consider them in conjunction, but I hope that the two elements brought into this chemical composition will prove less explosive than they do in their separate and individual character. At all events, I am certain that nothing I shall say will hurt the sentiments even of the most ardent opponents of the Education Act passed through Parliament last year, or will in the smallest degree anticipate that interesting discussion upon tariff reform with which it is promised us that the autumn is to be occupied. I mean to talk of education, and I mean to talk of Empire; but I hope and believe I shall tread upon nobody's toes, and that is partly because I think I am justified in treating very lightly on an occasion like this that part of the great educational problem which touches upon secondary education. I confess that, as far as I am concerned, I have never been able to make a theory satisfactory to myself as to what is or is not the best kind of education to be given in those great public schools which are the glory of our country, and which, in their collective effect upon British character, I think cannot be overrated, but which are subjected, and perhaps rightly subjected, to a great deal of criticism as to that portion of their efforts which is engaged on the scholastic and technical side of education.

I cannot profess myself to be satisfied with the old classical ideal of secondary education; and yet I am not satisfied—perhaps I ought to put it more strongly and say I am still less satisfied—with any substitute I have seen for it. I have heard the old system defended on the ground that the great classical languages contain masterpieces of human imagination which have never been surpassed; and, of course, that is true. But I do not think we can defend classical education in the great public and secondary schools on that ground alone. You have only got, after all, to make a simple statistical calculation, which perhaps we cannot put down in figures, but which every man with

the smallest experience, perhaps with the smallest memory of what he was and what his school fellows were at the age of seventeen or eighteen, can make, to know that the master of the dead languages of a kind which enables them to enjoy those great works with their foot on the hearth, which is the only way to enjoy any work of literature, the number of boys who leave the great public and secondary schools with that amount of knowledge is a very, very small percentage. You cannot keep up a system of education for a very, very small percentage; and, if that is the only defence of classical education, I think it will have to be abandoned except for the few who are qualified to derive all the immense advantages which to the few they are capable of imparting. But when I turn to the other side and ask what the substitute is, then I confess I am even less happy than when I consider the classical ideal; for I am quite sure—no, I am not quite sure, but I think—you will never find science a good medium for conveying education to classes of forty or fifty boys who do not care a farthing about the world they live in except in so far as it concerns the cricket field, or the football field, or the river—you will never make science a good medium of education for those boys; for only a few are capable at that age, and perhaps at any age, of learning all the lessons which science is capable of teaching. I go further. I never have been able to see, so far as I am concerned, how you are going to get that supply of science teachers for secondary schools who have both the time to keep themselves abreast of the ever-changing aspects of modern science and to do all the important work which the English schoolmaster has to do, which is that not simply of teaching classes, but of influencing a house and impressing moral and intellectual characteristics on those committed to his charge.

I do not know whether it was Lord Kelvin's presence which inspired me to say something which I was afraid he would not like. I did not mean to deal with this topic at any length. I only meant to say that while, as far as I am concerned, I think we have not yet arrived at the ideal system or the ideal character of our secondary and public school education, I do think that, so far as this assembly is concerned and the universities are concerned, we are on much more solid ground when we come to the education with which they have got to deal; and especially and chiefly do I say that we are on absolutely secure ground when we are dealing with that post-graduate education which, I hope, will be the great practical result, or one of the great practical results, of the meeting which I am addressing to-night. We know exactly what we want when dealing with post-graduate education, and it is our business to see that the students who desire it have it, and that the opportunity of those who do desire it is augmented so far as our influence will go. I daresay that many of us have looked back with a certain regret, and a certain feeling of shame, to the medieval passion for learning without fee and without reward—with no desire to make the universities stepping-stones to good places or to successful mercantile or industrial undertakings—but with an ideal which made thousands of students from every country in Europe undergo hardships which would be regarded in these softer days as absolutely intolerable, for the sole purpose of seeking, and it might be finding, the great secret of knowledge. We despise, and we perhaps rightly despise, their methods. We know that they were not in touch with the actual realities of the world in which they lived. Yet, after all, we have something to learn from them; and if we in these days could imitate their disinterested passion for knowing and for extending the bounds of knowledge, surely we, with our better methods, and our clearer appreciation of what we can know and what we cannot know, might accomplish things as yet undreamed of. Now, what did they do? They moved from university to university, from Oxford to Paris, from Paris to Padua, from country to country, in order that they might sit at the feet of some great master of learning, some great teacher who might lead their thoughts into undreamed of paths. I hope that in the universities of the future every great teacher will attract to himself from other universities students who may catch his spirit—young men, who may be guided by him in the paths of scientific fame; men who may come to him from north or from south; and who, whether they come from the narrow bounds of this island or from the furthest verge of the Empire, may feel that they have always open to them the best that the Empire can afford, and that within the Empire they can find some man of original genius and great teaching gifts who may spread the light of knowledge and further the cause of research.

I have said that they were to find this—I have suggested, at all events, that they should find this—within the limits of the Empire. I hope that in putting it that way I have not spoken any treason against the universality of learning or the cosmopolitan character of science. I quite agree that the discoveries made in one university or by one investigator are at once the common property of the world; and we all rejoice that it is so. No jealous tariffs stand between the free communication of ideas. And surely we may be happy that that is the fact. And yet, though knowledge is cosmopolitan, though science knows no country and is moved by no passion—not even the noblest passion of patriotism—still I do think that in the methods and machinery of imparting knowledge, as there always has been in modern times, so there may still continue to be, some national differentiation in the character of our universities, something in our great centres of knowledge which reflects the national character and suits the individual feeling, and that an English-speaking student and a citizen of the Empire, from whatever part of the world he may hail, ought to find something equally suited to him as a student, and more congenial to him as a man, in some university within the ample bounds of the Empire. If that be our ideal, we have to ask ourselves whether we have accomplished it, or whether we are in process of accomplishing it. I am afraid it is too clear that we have not accomplished it. But that we are in process of accomplishing it, and that we can accomplish it—of that I do not entertain the smallest doubt. The movement which has begun with the inter-university meeting, of which this is the culmination, that movement is not destined to finish with this evening's proceedings. It is but the beginning and the seed of far greater things. And I feel confident that, if the representative men whom I see here gathered together from all parts of the world should by good fortune meet a few years hence in this metropolis of the Empire, they will be able to say, and to say with confidence, that the work begun to-night has not been unfruitful; that the machinery for interchanging ideas between our great academic centres has worked admirable good, not merely for the individual student, and not merely for the cause of knowledge, but for the cause of Empire itself. And while learning ought never to be perverted to the cause of faction, or to the cause of separation between the different sections of mankind, yet nevertheless it will be true that this intercommunication of the highest thoughts between the leaders of academic training in every portion of the Empire to which we belong will have furthered not merely sound learning, but sound patriotism. It is in that faith that I have been proud to share, however humbly, the work on which you are engaged. It is this, I think, that will make memorable in academic history the undertaking which my friend, Sir Gilbert Parker, more, perhaps, than any man in this room, has set himself to accomplish; and it is in the cause of education, of learning, of research, of science, and of Empire that I now ask you to fill your glasses and drink to the toast of the universities of the King's over-sea dominions.

NOTES.

It is proposed to change the name of the Jenner Institute of Preventive Medicine to the Lister Institute of Preventive Medicine. A memorandum which has been sent by the governing body to the members of the institute states, as one reason for the change of name that there is in London a commercial firm trading under the name of "The Jenner Institute for Calf Lymph," with a prior legal claim to the name of Jenner Institute. So great has the inconvenience become on account of the confusion between the two institutes, that the governing body has determined to seek the sanction of their members and of the Board of Trade to change the name of the institute to the Lister

Institute of Preventive Medicine, though it is only fair to Lord Lister to say that this name was chosen by his colleagues against his own strong personal wish.

AT a meeting of the Wilts County Council last week, it was decided not to take over the powers and duties of the Amesbury Rural District Council in regard to the alleged rights of way to Stonehenge. Steps are being taken to ensure that the question of right of way shall be brought before a legal tribunal for decision, as the negotiations between the Government and the landowner for the purchase of Stonehenge have come to an end.

THE *Times* correspondent at Cape Town reports that on July 9 a slight earthquake was felt there at 11.37 a.m., followed by a second shock at 12.6 a.m., the latter being the heaviest known at Cape Town for twenty years. No damage was caused.

IT is proposed to hold an International Exhibition at Manchester in 1905. At a meeting recently held in that city, a committee was appointed to take such steps as they consider necessary to ascertain the views of those likely to be interested in such a project.

IN reply to a question asked in the House of Commons on July 8, Mr. Balfour stated that the King had expressed the wish that the Celtic gold ornaments declared by the judgment in the Court of Chancery to be treasure trove, and therefore the property of the Crown, should be presented as a free gift to the treasurer of the Irish Academy. The ornaments will therefore be taken from the British Museum and sent to Ireland.

THE whaler *Terra Nova* has been bought by the Admiralty to be sent to the relief of the *Discovery* in the Antarctic. The *Terra Nova* left St. John's for the Tay on July 9, and is to be fitted out, by instructions of the Admiralty, by the Dundee Shipbuilders' Company, who constructed the *Discovery*.

A PARIS correspondent writes:—Last week a visit was paid to the Moisson Aërodrome by the scientific committee of the Aëro Club, when the Lebaudy balloon made a successful performance, controlled by M. Juchmès and two assistants. During about twenty minutes the balloon travelled at an altitude of about 300 metres, and travelled in different directions for about a kilometre, in spite of a wind blowing at a measured rate of 6 to 7 metres in a second. The influence of the motion of the air was perceptible only by a great diminution of this velocity and large vibrations testifying to the effort exerted.

AMONG the subjects of resolutions adopted in general conference of the International Fire Prevention Congress, held in London last week, the following are of interest:—that in all reports dealing with questions of fire-resistance and tests, the metric system of measurement, weight, and temperature shall be adopted, as well as any local system; that there should be established testing stations for fire-resisting materials, and a universally recognised method of testing adopted; that courses of study should be provided in universities, technical colleges and schools, for the instruction of engineering and architectural students in the fire-resistance of building materials and the methods of construction as based on investigation; that having regard to the neglect of precautions against damage caused by lightning, the subject should have the serious consideration of the Government and local authorities, the technical professions, and the fire service.

MR. H. C. RICHMOND, of Southport, appreciating the highly interesting work of Jeremiah Horrox, is endeavouring to have erected to his memory some suitable memorial in Southport. Doubtless Mr. Richmond feels that the forthcoming meeting of the British Association in that town will awaken some scientific interest, and make easier the task to which he has applied himself. We can wish him all success in his praiseworthy effort to keep alive the memory of one whose genius has been the admiration of successive generations, and whose early death lent a pathetic interest to his work. Already a suitable tablet to the memory of Horrox exists in the Church of S. Michael in Liverpool, a window and memorial chapel commemorate his scientific zeal in the church at Hoole, and on the walls of Westminster Abbey there is other acknowledgment. Is another tablet precisely the form which the memorial should take? It would be just as fitting, and productive of more lasting benefit to the community, to found a Horrox scholarship for astronomy in the new University of Liverpool.

DR. E. C. HOVEY gives reasons in *Science* why the now celebrated volcano on the island of Martinique should be called by the French name Mont Pelé, and not the Anglicised Mount Pelee, in which there is little suggestion of the true pronunciation of the name.

MR. WALTER ROSENHAIN has sent a reprint of a paper read before the Optical Society of London on June 15, on some properties of glass. It deals with the crystallisation of glass due to heating, the effect of light on the colour of glass, the chemical instability of many of the most desirable optical glasses, and the thermal properties of glass, with especial reference to production of internal strains.

M. F. WORMS DE ROMILLY, whose funeral took place on May 3, has bequeathed to the French Physical Society a sum of 150,000 francs, together with his library and the whole of his apparatus. His telescope, the silvered glass mirror of which was made by Léon Foucault, is either to remain the property of the society or to be given to the National Observatory.

THE electrophorus is such a convenient apparatus for producing electricity for class experiments that the unsatisfactory explanations of its action given in many textbooks are to be regretted. Dr. Otto Geschöser, in the *Beitrage* of the Oels Gymnasium, describes simple experiments tending to show that the action of the electrophorus is to be attributed to "electromotive force of contact" between the resin disc and the metal plate, and that, so far from these acting as the plates of a condenser, the efficiency of the apparatus depends on the perfection of the contact between them. A modified form of electrophorus, in which the contact is made between silvered glass as a dielectric and copper as a conductor, is described.

THE *Bulletin* of the French Physical Society announces the opening of the new Laboratoire d'Essais du Conservatoire des Arts et Métiers. This laboratory has been founded with the assistance of considerable endowments from the Chamber of Commerce, for the purpose of undertaking measurements and determinations for commercial purposes. It consists of five sections, namely, physics, metals, building materials, machines, and vegetable products. M. Perot is director of the laboratory, and M. Raveau head of the physical department. Among other objects of the laboratory may be mentioned the testing of thermometers, and the standardisation of weights and measures where great precision is not required.

IN the *Proceedings* of the Royal Philosophical Society of Glasgow, Mr. R. F. Muirhead discusses a generalisation of Lord Kelvin's statement of the formula for direct refrac-

tion through a thin lens depending on the introduction of the term "divergence." Mr. Muirhead defines the *divergence* of a pencil of rays with regard to a refracting surface as the reciprocal of the effective distance (*i.e.* actual distance ÷ refractive index) of the surface from the apex of the pencil, and the divergivity of the surface as the divergence it produces on a pencil of rays originally parallel. Lord Kelvin's rule that "divergence after refraction equals divergence before refraction plus divergivity" then applies to refractions at single surfaces, and not merely to thin lenses in air.

Several articles on the subject of aërial navigation have lately reached us. Early in the year M. W. de Fonvielle discussed the general problem in the *Revue des deux Mondes*, with especial reference to the Bradsky disaster of October, 1902, and urged the desirability of not abandoning ordinary balloon experiments in favour of attempts with motor-driven balloons. In *Cosmos* for May 23, Lieut.-Colonel G. Espitalier gave an account of the new German balloon station at Renickendorf West, the installation of which includes a hangar 50 metres long, 25 metres wide, and 20·5 metres high. Finally, we have before us a paper by Mr. W. Rickmer Rickmers, entitled "Die Beherrschung der Luft" (Vienna), in which the author condemns as contrary to natural laws the attempts made to navigate the air by mechanically propelled balloons.

Prof. J. Hann presented to the Vienna Academy of Sciences on April 2 a treatise on the air-currents at the summit of the Säntis (2504 metres) and their yearly period. The investigation is based upon the anemometrical observations for fifteen years, and the author has calculated the values of the four wind components for each month, and separately for three five-yearly periods. It was satisfactory to find a considerable agreement of the yearly period of the components in each of the three lustra. The northerly component attains its greatest value in January and February, and its smallest value in July and August. The easterly component has nearly the same yearly period as the northerly, but the maximum in winter is more pronounced, and the minimum is from June to September. The contrast between the winter and summer half-year is very marked. The southerly component has a still more marked yearly range, with a maximum in October and November, and a minimum in June. The yearly period of the westerly component is less regular, but there is a decided maximum in July and August, and a similar minimum in April and especially in May. Among other interesting problems the author also endeavours to trace the relations between this yearly variation of the wind components and the distribution of air-pressure at sea-level. These are, on the whole, well marked, so that the distribution of pressure at a height of a mile and a half cannot differ much from that at the sea-level. The S.-N. component reaches its smallest value in May and its greatest in October; the W.-E. component has also its minimum in May, but its maximum in July and August. The resultant is W. 29° S., and varies but little during the year.

Dr. J. W. Kime, in an article contributed to the *Scientific American* of June 20, gives details of some experiments that show that sunlight will penetrate in a comparatively short time through a considerable thickness of flesh. He bound together a small negative and a gelatino-bromide plate of the ordinary kind (that is, not specially sensitised for colour) and put the combination between the teeth and the cheek of the subject, taking suitable precautions that no light should enter at the mouth. The cheek was then exposed to direct sunshine in February for forty seconds, and in every case it proved that the image was developable. Reproductions of the results of five experiments are shown, each with a different person. One man had a thick, short black beard, and this lessened the exposure effect somewhat. Another was a negro, with a thick, dark cheek; here the diminution in the light transmitted was still more marked. No steps were taken to interfere with the circulation of the blood, and Dr. Kime considers that his experiments show that it is not necessary, as has been stated, to compress the parts to free them from blood as far as possible when light is used as a surgical agent. Dr. Kime also states that his experiments show why red light is valuable in the treatment of small-pox. "They prove that no chemical light of any consequence reaches the patient" when red curtains are fixed over the windows, &c., and so irritation is prevented and subsequent disfigurement lessened. But as the photographic plates used were not sensitive to red light, the soundness of this deduction from the experimental results may be doubted.

It is stated that the radium rays have been successfully applied in the treatment of a case of cancer by Prof. Gussenbauer, of Vienna. The tumour completely disappeared as a result of the application, radium bromide being made use of as a source of the rays. The early publication of these details in the public Press before there has been time to test the method effectually is much to be deprecated.

Prof. Finsen, of Copenhagen, in a note upon the light treatment of lupus (*Acad. des Sciences*, Paris, June 22), points out that it is necessary to employ light of the greatest intensity in order to obtain penetration of the tissues, and states that his results have been much better since employing arc lamps, using a current of 60–80 amperes, than previously with 40 ampere lamps, the former penetrating in 20–25 seconds to a depth which formerly occupied 4–5 minutes.

Drs. Dutton and Todd, of the Liverpool Trypanosoma Expedition to Gambia, have just returned to England. They state that the disease occurs frequently both in natives and Europeans, and that it is distributed from the sea to the Upper Gambia. Besides the human disease, there is also an affection of the horse in the same region, caused by a trypanosoma, and resembling somewhat the "tse-tse" fly disease, but being more chronic. This is in all probability a disease distinct from the "tse-tse" fly disease. A mass of material has been brought home which will necessitate some time to work through.

Mr. B. Timothy sends us from Waterford an abnormal corolla formed by the union of several flowers, found growing on the apex of the stem of a foxglove, and surrounding the stem entirely. A botanist to whom we submitted the specimen remarks in reply that this abnormal development of a foxglove is "a case of *peloria*, that is, a change or reversion from an irregular to a regular condition of the flower; in this instance there is an additional abnormality, since the pistil has proliferated, *i.e.* instead of carpels an inner flower has been formed which bears stamens, but inside the carpels again have produced vegetative structures, the bracts."

A fine sample of the Okapi (*Ocapia johnstoni*) has recently been acquired by the Hon. Walter Rothschild for his collection at Tring. The modelling has been entrusted to Mr. Rowland Ward.

In vol. lxxiv. part iii. of the *Zeitschrift für wissenschaftliche Zoologie*, Mr. R. Weinberg publishes the first of a series of articles on the brains of fossil vertebrates, dealing in this case with the small Tertiary perissodactyle

Anchilophus desmaresti. The brain of this mammal, it appears, although essentially primitive, exhibits all the characteristic ungulate features, with a marked approximation towards the modern perissodactyle type.

To the June number of the *Zoologist* Mr. Lydekker contributes a note on the probable use of the bilobed canine tooth of the giraffe and its allies, which forms the outermost of the four pairs of lower front teeth. It has been observed that, when browsing, a giraffe (unlike a deer or an antelope) strips the leaves from the branches without biting off the twigs, and it is inferred that the complex structure of the canine is designed to aid in this "combing" action.

THE June issue of the *Economic Proceedings* of the Royal Dublin Society is devoted to an account, by Mr. G. H. Carpenter, of injurious insects and other animals observed in Ireland during 1902. Special interest attaches to two excellent illustrations, one showing the caterpillar of the ghost swift moth (*Hepialus humuli*) feeding on the roots of wheat, and the other the injury done to young wheat by the maggot of the wheat-bulb fly (*Hylemyia coarctata*). Reference is made to the new fern-weevil (*Syagrius intrudens*) recently described by Mr. Waterhouse on the evidence of imported specimens found in the fern-houses at the Royal Botanic Gardens, Glasnevin.

THE Cairo Survey Department has recently published a preliminary description, by Messrs. Andrews and Beadnell, of the remains of a giant land tortoise (*Testudo ammon*) from the Eocene of the Fayum district. The especial interest of this form is its antiquity, which far exceeds that of all other known members of the group. Dr. Andrews thinks it probable that *T. ammon* is the ancestral form of the giant tortoises met with in several European Tertiary horizons, and that the existing African *T. pardalis* may be a small survivor of the group, to which the Siwalik *T. atlas* and *T. cautleyi*, and the existing *T. sumeirei* (the well-known giant tortoise of Port Louis) may also pertain.

IN the current number of the *Zeitschrift für physikalische Chemie* Prof. F. Kohlrausch gives a summary of the work which he has carried out during the last thirteen years on the electrical conductivity of saturated solutions of slightly soluble salts. In all forty-one such salts have been investigated, and the electrical conductivities determined at different temperatures. The data are to be used for the calculation of the solubilities of the various salts, and the numbers, which must be of considerable value to the analytical chemist, are to appear in a later paper.

THE results of a careful investigation by Dr. Freundlich on the precipitation of colloidal solutions by electrolytes are published in the current number of the *Zeitschrift für physikalische Chemie*. The capacity of different electrolytes for precipitating the colloids is dependent, in a large measure, on the valency of the ions, this capacity increasing with increase of valency. For colloids which show anodic convection under the influence of an electric current, the nature of the anion is without influence, whilst for those which exhibit kathodic convection the precipitation is independent of the nature of the cation.

AN interesting account of the behaviour of chlorine towards benzene under the influence of various catalytic agents is given by Mr. Slator in the *Journal* of the Chemical Society. With iodine chloride as catalytic agent, about 70 per cent. of the reacting chlorine is used up in the production of chlorobenzene, while the remaining 30 per cent. disappears in the formation of the addition compound benzene hexachloride. When tin tetrachloride and ferric chloride are employed as catalysers, the whole of the chlorine is used up in the substitution reaction. On the other hand, when chlorine interacts with benzene under the influence of light, addition only takes place.

FOR many years past it has been the practice of the Iron and Steel Institute to republish from time to time rare and interesting papers relating to the history and manufacture of iron and steel. With the permission of the council of the British Association, the institute has now added to the series the report presented by Bunsen and Playfair to the British Association at Cambridge in 1845, on "The Gases Evolved from Iron Furnaces, with Reference to the Theory of the Smelting of Iron." This research has long been looked upon as a model of the application of the methods of scientific investigation to the elucidation of industrial problems.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Miss Gayner Rowland; two Bristly Ground Squirrels (*Xerus capensis*) from South Africa, presented by Mr. H. J. Palmer; a Ruddy Ground Squirrel (*Xerus rutilus*) from Burao, East Africa, presented by Mr. Bennett Burleigh; a Brazilian Tapir (*Tapirus americanus*), a Red Brocket (*Cariacus rufus*) from Manáos, Brazil, presented by Mr. Charles Booth; a Grand Galago (*Galago crassicaudata*) from East Africa, presented by Captain C. Mylton Thornycroft; three Fat-tailed Desert Mice (*Pachyuromys dupresi*) from Egypt, presented by Dr. H. P. Keatinge; an Undulated Grass Parrakeet (*Melopsittacus undulatus*) from Australia, a Goldfinch (*Carduelis elegans*), European; a Red-bellied Waxbill (*Estrelda rubiventris*) from West Africa, a Yellow-bellied Liothrix (*Liothrix luteus*) from India, presented by Mrs. Halsey Ralph Ricardo; a Punjaub Sheep (*Ovis cycloceros*) from North-west India, two White-necked Cranes (*Anthropoides leucachen*) from Japan, four Demoiselle Cranes (*Anthropoides virgo*) from North Africa, purchased; a Burrhel Sheep (*Ovis burrhel*), a Sambur Deer (*Cervus aristotelis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET 1903 *c*.—A new ephemeris, calculated from new elements by Herr M. Ebell, is given in Kiel *Circular* No. 62. It extends to a later date than the one previously published by M. Fayet, and also varies slightly from that one. The following data are given for the four last dates included in the new ephemeris:—

Ephemeris 12h. (M.T. Berlin).

1903	α h. m. s.	δ ° ′	log Δ	Brightness
July 17	... 18 41 11	... +62 2·2	... 9·4324	... 14·6
„ 19	... 17 7 44	... +67 35·1	... 9·4553	... 14·2
„ 21	... 15 22 3	... +68 36·0	... 9·4906	... 13·1
„ 23	... 13 59 5	... +66 17·8	... 9·5327	... 11·7

The following observations of this comet are recorded in No. 3882 of the *Astronomische Nachrichten*.

Dr. Meyermann, using the Kreutz micrometer on a 6-inch comet-seeker, and Prof. Ambronn, with the Repsold heliometer, record that on June 23 the comet was 2′ in diameter and had a faint tail, whilst for June 24 the latter observer records that in difficult "seeing" a faint tail extending towards the south was seen.

Prof. Hartwig, using the Bamberg heliometer, records that on June 23 the nucleus was between the tenth and eleventh magnitudes, and the tail was of the divided form, having a mean position angle of 250°, whilst the coma was about 10′ in diameter.

Prof. Millosevich, observing at Rome with a 39cm. equatorial and a filar micrometer on June 23, recorded a 9·5 magnitude nucleus, and a very short tail, which extended in a S.S.W. direction.

SEARCH-EPHEMERIS FOR COMET 1896 V. (GIACOBINI).—A further instalment of the ephemeris of this comet is published in the *Astronomische Nachrichten*, No. 3881, by Herr M. Ebell.

The following is an extract from the ephemeris, which takes June 22·5, 1903 as the time of perihelion passage :—

Ephemeris 12h. (M.T. Berlin.)

1903	α h. m. s.	δ ° ′	log r	log Δ	Brightness.
July 16	1 59 36	+17 33·9	0·1697	0·1065	2·55
,, 24	2 20 51	+18 16·6	0·1749	0·0970	2·60
Aug. 1	2 40 51	+18 41·6	0·1814	0·0874	2·64
,, 9	2 59 22	+18 49·1	0·1889	0·0776	2·67
,, 17	3 16 7	+18 39·7	0·1975	0·0676	2·69
,, 25	3 30 50	+18 14·0	0·2068	0·0573	2·70
Sept. 2	3 43 15	+17 33·2	0·2168	0·0468	2·70
,, 10	3 53 10	+16 38·3	0·2272	0·0364	2·70

The continuation of this ephemeris indicates that, after the last-mentioned date, the comet will slowly decrease in brightness.

THE LIMITS OF UNAIDED VISION.—Lick Observatory *Bulletin* No. 38 gives an account of some interesting observations made by Mr. Heber D. Curtis, at Prof. Newcomb's suggestion, on the inferior limit of magnitude obtainable in naked-eye observations.

A preliminary examination of previous naked-eye catalogues showed that the mean magnitude of the faintest stars included in Ptolemy's Almagest was 5·38 on the scale of the Harvard Photometric Durchmusterung, whilst Houzeau in his "Uranométrie Générale" stated that stars of the sixth magnitude were constantly seen in a clear atmosphere, and those of magnitude 6·7 could be seen at intervals; the latter value corresponds to 6·40 on the Harvard scale. Gould, in the introduction to the "Uranometria Argentina," states that 6·5 was the average limit at Cordoba, but on exceptionally clear nights the seventh magnitude was possible. These two values are respectively equivalent to 6·16 and 6·71 on the Harvard scale.

In his own observations Mr. Curtis used two large blackened discs to screen off the diffused sky-light, these two discs being attached to the 12-inch telescope at a distance of 178 inches from each other, and the front one pierced by a circular hole half an inch in diameter, the rear one by a quarter-inch hole. By this arrangement he was able, on a night when a 6·53 magnitude star could be seen without using the discs, to see the following stars in the regions about T Virginis and T Ursæ Majoris respectively :—

Bonn DM. number	Declination ° ′	Magnitude	
3219	− 4 40	7·31 HP[1]	Seen quite easily.
3459	− 5 23	8·3 H[2]	Seen with considerable difficulty.
3463	− 5 37	8·1 H	Seen without difficulty.
1413	+60 18	8·3 H	Seen with difficulty.
1415	+60 13	8·5 H	Glimpsed at intervals; very doubtful.
1457	+59 30	8·2 H	Seen.

Mr. Curtis found that the screening off of the diffused light was even of more importance than knowing exactly where to look for the object.

AN ETHNOGRAPHICAL EXPEDITION TO BRITISH NEW GUINEA.

THERE are few areas of equal extent that present so many interesting sociological and cultural problems as British New Guinea. It is necessary these should be studied on the spot, and that, too, with as little delay as possible, for, even there, the remorseless activity of the white man is rapidly making itself felt.

We know there are various cultural provinces in British New Guinea which, in certain respects, are markedly distinct from each other; for example, we recognise districts that may, for the present, be conveniently distinguished by the geographical terms of Western, Fly River, Papuan Gulf, Central, South-Eastern, and North Coast, and some of these districts are capable of further subdivision. In most cases it is possible to tell within comparatively narrow limits the provenance of a decorated object by its form, technique, and the motive of its ornamentation. Although these general facts are well known to ethnological experts, there is still lacking an immense amount of detailed information of even these relatively superficial data that can be acquired only in the field. It is one thing to know what an object is and where it comes from, but it is much more important to understand the meaning of its form and decoration, and arm-chair musings, or even comparative study in museums, will be of little avail in this inquiry; on the contrary, they are liable to lead one astray.

It is becoming more and more recognised that the religion of primitive peoples is manifested in their arts and crafts, and that it is itself a reflex of their social condition. A student begins by being interested in patterns, is led into a study of comparative religion, and ends in sociology. In British New Guinea these several subjects have a peculiar interest. The decorative art is rich, varied, and distinctive. Concerning the religion very little is known; we are aware that true totemism occurs in the west, and it is probable that all stages, from animal reverence, through a hero-cult to an actual hierarchy of gods can be traced from the Netherlands boundary to the bight of the Papuan Gulf. The recognition of personal powers superior to man seems to be lacking in the Central District, and in the South-east District totemism again appears, and there is, or has been, a regard for the frigate bird, which in any case is probably not now totemic, but of the significance of this probable cult of the frigate bird we have at present not a particle of evidence. As to sociology, we have indications that British New Guinea possesses many varied and interesting aspects, and there is every reason to suspect a gradation in social structure will eventually be revealed that will illustrate some important phases of social evolution.

These are but one or two of the many promising fields of inquiry that British New Guinea affords to the ethnologist. At present we have but enough knowledge to appreciate the fact that there are these unsolved problems—the information being merely sufficient to emphasise our ignorance. It was his appreciation of this fact that led Major W. Cooke Daniels to organise an expedition to British New Guinea which will leave this country in August.

Major W. Cooke Daniels served in the United States Army during the Cuban campaign as Adjutant-General of Division. He has travelled extensively in British Guiana and elsewhere, and has consequently had much experience of travel and of organisation. He proposes to make observations in experimental psychology, and will undertake ethnological investigations. Dr. C. G. Seligmann, of St. Thomas's Hospital, was a member of the recent Cambridge Anthropological Expedition to New Guinea and Sarawak, and consequently has had considerable experience in anthropological field work. As the representative of the Cancer Commission on the expedition, he will investigate the question of the prevalence and incidence of tumours, especially those of a malignant type. He has care of the health of the expedition, and will help in the ethnological inquiries.

Dr. W. Mersh Strong, of Trinity College, Cambridge, will be responsible for the geographical and geological observations, and will undertake pathological and medical research as opportunity offers.

Preparations have been made for the taking of a very large number of photographs, including kinematograph records; this department is in charge of Mr. A. H. Dunning.

Major Daniels is sending to Australia for the expedition's use a schooner yacht fitted with auxiliary power; a sea-going launch is being taken out for river work. The expedition is fitted with a large amount of scientific equipment, so that all departments of anthropological research can be prosecuted. The majority of the surveying instruments have been lent by the council of the Royal Geographical Society. The Government Grant Committee has shown its appreciation of the expedition by giving a small grant, and the Royal Society has furthered its objects in various ways. The expedition is also recognised by the Cancer Commission.

It will be seen that the Daniels Ethnographical Expedition to New Guinea is thoroughly equipped, and we wish it the success it deserves.

[1] HP = Harvard Photometric Durchmusterung.
[2] H = Hagen's "Atlas Stellarum Variabilium."

ON A PROBABLE RELATIONSHIP BETWEEN THE SOLAR PROMINENCES AND CORONA.[1]

IN a previous number of this Journal (NATURE, vol. lxvii. p. 569, April 16) an account was given of the results which had been deduced from a minute investigation of the percentage frequency of prominences as determined from observations made by Secchi and Tacchini at Rome, and Ricco and Mascari at Catania and Palermo. It was there shown that the chief centres of prominence action, that is, the zones in which the greatest percentage frequency of prominences occurred, indicated movements in heliographic latitudes, the general tendency of these being in a direction towards the solar poles, and not towards the equator, as is the case with the spots. Attention was also directed to the fact that these centres of prominence activity were not restricted to a narrow zone like the spots, which only occur between the latitudes ±5° and ±35°, but that at times they were numerous in such high latitudes as ±80°, and even higher.

The present article contains an account of the results of a general survey that has been made regarding the connection between the changes of position of these centres of prominence action and the various forms of the corona as observed during total eclipses.

It has been suggested, and the idea is generally accepted, that the various forms of the solar corona are intimately connected with the variation in the spotted area of the sun's surface. Thus, generally speaking, at about the epochs of sun-spot maxima, the corona is apparently very irregular in shape, there being little or none of the exquisite tracery at the sun's poles which is so evident at the epochs of sun-spot minima, while the streamers are less confined to mid-solar latitudes and the region near the equator than they are at the minima.

The facts that sun-spots do not appear nearer the poles than latitudes ±35°, and that large coronal streamers and prominent rays are sometimes visible in much higher latitudes than these—in fact at times near the poles of the sun, and consequently outside the regions of spot activity—suggested that the occurrence of prominences, very important factors in the mechanism of the solar atmosphere, might be closely connected with them.

In the present general inquiry, the forms of the coronas that have been observed since the year 1857 have been divided into three main types, and this classification, which is not new, is one into which most of the coronas, with the exception of two, namely 1865 and 1885, can be easily placed. Since the forms of coronas are dependent chiefly on the positions of the coronal streamers, the three different types here adopted refer in the main to the positions of these streamers in relation to the solar equator and poles.

In the first, or "polar" group as it has here been called, since streamers are found near the solar poles, all those coronas are included which seem to have no regular form. The typical features of this group are that the polar rifts are absent, being replaced to a great extent by streamers at, or very close to, the poles, and the streamers are numerous in nearly all solar latitudes; also there is no definite equatorial extension. To this class the following coronas belong, 1860, 1870, 1871, 1882, 1883, and 1893.

In the third, or "equatorial" group, since the streamers are in lower latitudes, and consequently more equatorial, the form of the corona is very regular. The polar rifts have a great spread in latitude and are well defined, while the large streamers are restricted to the regions near the equator; in fact, the great equatorial extensions are best seen in this type. This form generally takes the shape of a "wind vane," and is often referred to as such. The coronas which come into this category are those of 1867, 1868, 1878, 1889 January, 1889 December, 1900 and 1901.

The second group of this classification may be termed the "intermediate" type, as the streamers are about half way or intermediate between the poles and the equator. In this group the polar rifts are present, but they are not so extensive in latitude as in the "equatorial" class. The coronal streamers also approach nearer the polar regions than in the "equatorial" class, but not so close as in the "polar" group, while the equatorial extensions are not in such great evidence. Generally speaking, this form of corona is due to a large streamer in each quadrant, which gives the corona the appearance of a square, hence the name "square corona," which has been often used.

The coronas which fall under this heading are 1858, 1869, 1874, 1875, 1886, 1887, 1896, 1898. It may be stated

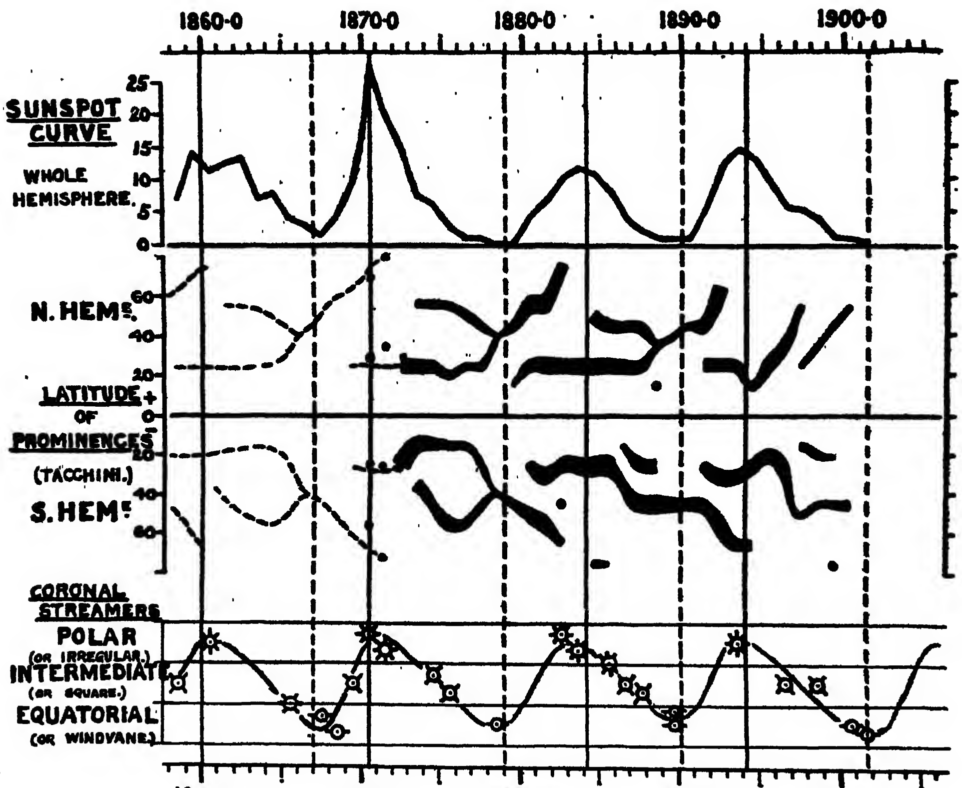


FIG. 1.—Curves showing the relationship between the different forms of the corona, the positions of the centres of action of prominence phenomena and the general sun-spot curve. The continuous and broken vertical lines indicate the epoch of the maxima and minima respectively of the last mentioned curve.

[1] Abstract of a paper recently communicated to the Royal Astronomical Society by Dr. William J. S. Lockyer.

that the "polar" and "equatorial" coronas are always followed by "intermediate" types, the order being polar, intermediate, equatorial, intermediate, polar, &c.[1]

The "intermediate" type may sometimes approach in form a "polar" or an "equatorial" type, according as the epoch of the occurrence of the eclipse occurs nearer or further from the epochs of occurrence of polar prominences.

Further, the "intermediate" type preceding a "polar" type will differ to some extent from one immediately following a "polar" type, because the latitudes of the centres of prominence action in each case are different, as can be seen from the accompanying figure.

Two coronas which have not yet been classified are those of 1865 and 1885. The former of these is of a type between the "intermediate" and "equatorial," while the latter falls between the "polar" and "intermediate" groups. These have been inserted on the dividing lines in Fig. 1. In classifying the coronas into the above groups, I have been greatly assisted by Mr. W. H. Wesley, to whom I wish to express my best thanks.

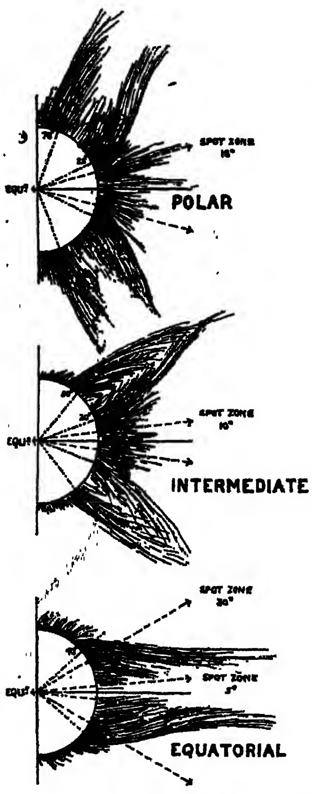


FIG. 2.—Diagram showing by radial lines the positions of the centres of prominence action and their relation to the chief features of individual coronal streamers and to the general form of the corona. The positions of the sun-spot zones are also indicated.

The first natural and crucial test to apply, in order to determine whether there was a connection between prominences and the different forms of the corona, was to inquire whether the coronal streamers were situated nearest the solar poles, at those times when the prominences were most numerous in those regions.

The comparison for this test showed that the only five "polar" coronas recorded since the year 1869, when prominence observations were commenced, occurred at those epochs when the prominences attained their highest latitudes.

This satisfactory result indicated a very probable cause and effect between prominences and the coronal streamers, for the region considered was quite outside the zone of the spots, and therefore independent of them.

It was next found that the other two types of coronas were closely associated with the number and latitudes of the centres of prominence action. Thus the "equatorial" type only occurred when there was *one* definite centre of prominence action in each hemisphere, while the "intermediate" type has been recorded at those times when *two* centres of action in each hemisphere were in progress, neither of which were in very high latitudes.

The accompanying illustration (Fig. 1) shows the relationship between the sun-spot curve for both hemispheres together, the latitudes of the centres of action of the solar prominences for each hemisphere, explained in detail in a previous number of this Journal (NATURE, vol. lxvii. p. 569, April 16), and the times of occurrence of all the eclipses that have occurred since the year 1857. When two eclipses of a similar type occur in the same, or two successive years, they have been inserted either one above the other or obliquely, respectively, to avoid overcrowding. A curve is also drawn through the different types showing their relation to the sun-spot curve.

Since the systematic prominence observations only commenced in the year 1872, the dotted portions of the curves previous to that date are intended only to give a rough idea of the variations as based on a general repetition of the observations of 1872 to 1885.

Fortunately for the present inquiry, Respighi made some very valuable prominence observations during the years 1870, 1871, and 1872, which are sufficiently numerous to indicate the positions of the centres of prominence activity for these years. These showed that during the years 1870 and 1871 there were two well-marked prominence zones in each hemisphere, and that the latitude of one of the zones was very high. The positions of these zones are indicated in the accompanying figure by the small dots against these years, and they agree well with the suggested curves representing the probable conditions as might have been expected from subsequent observations.

The different types of corona are plotted in three different horizons in the order "polar," "intermediate," and "equatorial," and the symbols adopted for each, namely, small circles with 8 rays for the first, 4 rays for the second, and 2 rays for the third, are inserted at the epochs of their occurrence according to the general time scale for all the curves. The continuous and broken vertical lines denote the epochs of the sun-spot maxima and minima, as determined from a discussion of spots recorded on both hemispheres of the sun.

At the first glance it will be observed that the three types of the corona, as seen from the curve drawn through them, follow the sun-spot curve very closely, that is, that at about the times of the maxima of sun-spots, the "polar" type is present; at the minima, the "equatorial" type; and at the intervals between these, the "intermediate" type. Although the sun-spot curve thus affords a means of predicting in a general manner the epochs about which any of these types will occur, such a small restricted zone which the spots occupy excludes the idea of their presence being responsible for such widely distributed coronal phenomena.

The prominence curve, on the other hand, not only provides one with a more accurate method of forecast, but such phenomena *can account for the general changes of position and form of the coronal streamers.*

By examining the prominence curves in relation to the three different types of coronas from the year 1869, this connection is seen to be very close. Thus, during the years 1870 and 1871 there were two centres of prominence action in each hemisphere, one of which was in high latitudes, and the coronas for that period were of the "polar" type. From the year 1872 to 1877 there were two centres of prominence activity in each hemisphere, both in comparatively low latitudes, and the two eclipses during the period, namely, 1874 and 1875, were of the "intermediate" type. The next eclipse, 1878, occurred when only one centre of action was in existence, and the form of the corona was of the "equatorial" type.

As these centres of prominence action reached their extreme polar limits (about $\pm 80^\circ$), and a new centre had in the meanwhile commenced in lower latitudes ($\pm 25^\circ$), the eclipses of 1882 and 1883 were of the "polar" type.

The next two eclipses, of 1886 and 1887, which were "intermediate," occurred when there were again two centres of prominence action in each hemisphere, but none near the poles. When the centres became single, as they did in the years 1889, 1890 and 1891, the two coronas observed in the year 1889 were of the "equatorial" type. With the movement of these centres to high latitudes in the years 1892, 1893, 1894, the eclipse of 1893 was of the "polar" type.

The two eclipses of 1896 and 1898, which were "intermediate" in type, occurred when there were two chief centres of prominence action, while the two most recent eclipses of 1900 and 1901 were good examples of the "equatorial" type, and were concurrent with only one centre of prominence activity in each hemisphere.

If the eclipses observed between 1856 and 1870 be compared with the dotted prominence curves for the same

[1] It may be here remarked that the "intermediate" type between an "equatorial" and "polar" type has only once (1869) been recorded during the period here under investigation, and this is due to the absence of observed eclipses during the two short available periods since that date, namely, 1879–81 and 1890–92.

period, it will be seen that a similar connection seems to exist between the latitudes of the centres of action of the prominences and the three types of coronas.

The investigation seems to indicate that it is the *sum total of prominence action* in the different zones which produces the large coronal streamers, and not any particular prominence at any particular moment; it is for this reason that the form of the corona is not a fleeting phenomenon changing every minute or hour, but one lasting over several months, and sometimes as much as a year or more. That the general form of the corona does undergo comparatively slow changes is borne out, to a great extent, by the similarity of coronas which are observed at eclipses which occur close together, such as those in 1900, 1901, the two eclipses in 1889, &c.

It is of great interest briefly to note the connection between the centres of prominence action when either two or one of them exist in each hemisphere. In the first place a well-defined large coronal streamer apparently originates, as many photographs indicate, not from disturbance at the *centre* of its base, but near the two ends. Such a streamer is generally made up of groups of incurving structure, termed previously "synclinal" groups, and this structure is, in many cases, very distinct. When there are *two* centres of prominence action in one hemisphere, the coronal disturbances resulting from each trend towards each other, and constitute a large streamer with an apparent "arch" formation. If the two centres of prominence action exist in comparatively mid-latitudes, one large streamer is formed in each quadrant, and the form of the corona is of the "intermediate" or "square" type.

When one of the centres is near the region of the poles and the other in comparatively low latitudes, the tendency is still for the two disturbed coronal regions to trend towards each other, but they constitute either a large streamer of an "arch" formation nearer the solar poles with a very extended base, or two separate streamers which combined have a fish-tail appearance.

With *one* centre of action of prominences in each hemisphere, the resulting coronal disturbances in both hemispheres curve towards the solar equator, and form apparently a large equatorial streamer; the "equatorial" type of corona is here formed.

The accompanying sketches (Fig. 2) illustrate in diagrammatic form the general relationships between the latitudes of the spot zones, the latitudes of the centres of action of the prominences, and the suggested resulting positions and origin of structure of the coronal streamers for each of the three types of coronas here discussed. It will be noticed that in the case of the "polar" and "intermediate" types, when the sun-spots are numerous, the zones in which they occur have apparently little connection with the coronal streamers. When the latitudes of the spot zones do approximate more nearly to the bases of the coronal streamers, as in the "equatorial" type, and might be considered as being the origin of their existence, the spots at these epochs are near a minimum, that is, are very few and small in size, and have the least power of action.

WILLIAM J. S. LOCKYER.

SOME PRESENT AIMS AND PROSPECTS OF MATHEMATICAL RESEARCH.[1]

IT may be doubted on the whole whether any completely scientific and permanent dividing lines for the classification of modern original work of pure and applied mathematics can be drawn.

The nearest approach is perhaps an arrangement according to motive. Thus a first class may be constituted of those investigations which aim at discovering and establishing the foundations of the subject, and obtaining rigorous proofs of theorems already known; such work as that which Peano and Russell are doing in their symbolic notation for the general principles of mathematics, or Pieri and Veronese for the axioms of geometry, or Picard for the existence theorems of differential equations, or Vallée-Poussin for the differentiation of definite integrals.

[1] From an address by Mr. E. T. Whittaker on "Some Present Aims and Prospects of Mathematical Research," delivered before the University College Mathematical Society on June 25.

Although the primary aim of such papers is that of imparting a strict logical rigour to the theory discussed, yet the most surprising and unexpected new results are constantly arising in them; as an instance, I may mention Fano's discovery of a space which consists only of 15 points, and which satisfies all the conditions for an ordinary projective space except the condition that each part is to be distinct from its harmonic conjugate; or the remarkable result that a projective geometry of two dimensions cannot be obtained without the supposition that the two-dimensional space is contained in a three-dimensional space; or the well-known theory of Fourier series and integrals which can represent different analytic functions in different parts of their domain of existence. It is a notable fact that this type of research seems peculiarly congenial to the mind of the Latin races. Undoubtedly much work of the kind has been done in Germany during the nineteenth century, but the honour of its foundation must be assigned to Cauchy, and its home has always been in France and Italy. In this country it has never thoroughly taken root, perhaps because, as someone said, the Englishman cannot distinguish between a proof and an appeal to the jury. In America, however, a considerable amount of attention is now given to the subject by such writers as Moore, Osgood, Bôcher, and Huntington.

A second class of research can be formed from those which are directly provoked by some observed phenomenon of nature, researches of which the immortal type is Newton's discovery that if the planets move in ellipses with the sun in one focus, it must be because they are attracted to the sun with a force which varies as the inverse square of the distance.

In work of this kind our country has always borne a distinguished share; the greatest achievements of the English school of mathematical physicists must all be included in it, and even at the present time no paper excites so much interest among us as one which gives a mathematical explanation of the Zeeman effect or the second law of thermodynamics.

A third class of investigations may be made to consist of those in which the motive is not in some external phenomenon, but in what may be called the internal expansive force of the subject itself, the inherent capability of extension, which is latent in every theorem of mathematics, the desire of the mathematician who has solved the quadratic equation to solve the cubic and quartic, and then either to solve the quintic or to show that it cannot be solved by radicals.

This, which is by far the largest of the three classes, admits of several subdivisions, according as the successful issue of the work is due mainly to the author's geometrical imagination, as in the writings of Cremona and Chasles, or to his power of algebraical analysis, as in much of the work of Jacobi and Cayley, or to his having brought to bear on the subject a novel set of ideas, as, for instance, in Fuchs's papers on linear differential equations, or to what may be called pure constructive intuition, which does not depend on the extension and generalisation of preceding results, as for instance, Euler's expression for the gamma-function as an infinite product, or his solution of the many types of differential equations.

The second of these subclasses, namely, that in which the successful management of highly complicated symbolic work is the most prominent feature, has flourished perhaps more than any other branch of non-physical mathematics in our own country.

It may be questioned whether this is not in part a consequence of the traditional English mode of training, which includes far more working of hard examples than is customary abroad, and thereby gives the mathematician that algebraical power which comes of much practice: but no one can see such work as that of Cayley or Forsyth without feeling that it is largely due to an inherent algebraic power with which our distinguished fellow-countrymen have been endowed. The introduction of new algorithms and new concepts is, on the other hand, a German characteristic; a notable instance is furnished by the invariant-theory, which, after its first development by Cayley and Salmon on purely algebraical lines, was transformed by Aronhold's introduction of the symbolic notation. The *Mengenlehre* of Cantor, the Ausdehnungslehre of Grassmann, numerative geometry and the theory

of algebraic numbers, are instances of subjects the inception of which we owe to the Germany of the nineteenth century.

While, as we have already remarked, the English have shown a considerable interest in some branches of research, it is often said, and I think with truth, that our record in the history of modern mathematics is not worthy of our place among the nations. It is, at any rate, a fact that a considerable number of men spend the greater part of their student life in the special study of mathematics, and after a successful college career are appointed to teaching posts which leave them a fair amount of leisure for the pursuit of their chosen subject, and that, nevertheless, their life is barren of contributions to learning. This state of things, which we must admit to be much more general in this country than on the Continent, is, perhaps, the gravest feature in the situation at present, and it becomes deeply interesting to attempt to trace its course.

The explanation which I personally favour places the origin of the evil back in student days, and in our methods of instruction. The most casual reader of text-books cannot fail to be struck by the fact that English text-books treat their subjects in much greater detail than is customary on the Continent; innumerable side-issues are raised, trifles are elaborated, and examples are multiplied a hundredfold. Moreover, topics which have now become comparatively unimportant, or even positively obsolete, are always retained, and each text-book differs from its predecessor only in a further increase of prolixity.

The result is that even the best men cannot, in a student course of many years, wade through this mass of material to the frontier of existing knowledge, and the unfortunate student finds his college career over and his teaching life begun before he has gone anything like far enough to begin independent research.

I can scarcely conceive a greater benefit to the study of mathematics in this country than a series of short text-books holding closely to the main lines, casting away the rubbish and the trifles, and carrying a student to the furthest boundary of learning in a three years' university course.

Although the evil relates chiefly to college text-books, it would not be difficult to mention branches of higher learning the progress of which has been arrested for a long period simply by the publication of unreadable accounts of them.

In order that our research may be the worthy centre of a life-work, it is needful to have not merely the equipment of a full knowledge of the past, but also a clear and well-defined idea as to which are to be considered the chief and which the minor objects of investigation. For the next worse thing to doing no research at all is to spend one's time on matters that are of very little consequence.

This point is all the more important because there is every indication that we are now at a critical point in the history of mathematics, and that the twentieth century will see progress in somewhat different directions from those which characterised the last half of the nineteenth.

Let me recall the fact that, from the time of Newton to the death of Cauchy in 1857, the main progress of mathematics was in the realm of analysis—the science which is based on Newton's infinitesimal calculus, and which was enriched by all the greatest masters, Euler, Lagrange, Laplace, D'Alembert, the Bernouillis, Taylor, Legendre, Fourier, Gauss, Abel, Jacobi, and Cauchy.

The latter half of the nineteenth century saw, however, a notable change. As in the hands of these giants even the inexhaustible mine of analysis seemed to be worked out, new subjects came into prominence, such as invariants, the theory of groups, the Mengenlehre, analysis situs, quaternions, and non-Euclidean geometry; the theory of functions developed itself on lines quite foreign to the older analysts, and the demand for rigorous proofs led many even of those who remained in the domain of analysis, as Du Bois Reymond and Pringsheim, to devote themselves rather to a careful investigation of the foundations than to an extension of the superstructure. Now, however, we seem to be on the threshold of a change. The branches of mathematics the introduction of which we owe to the last generations of German mathematicians are already beginning to show signs of exhaustion—by which I mean that further work in such a subject as the invariant-theorem along the present lines does not promise to yield any great increase of mathematical power; the process of underpinning the edifice has now been, to a great extent, accomplished, and the work of upbuilding can be recommenced, while the interest of the theory of functions has largely passed over into topics of a distinctly analytical character, such as the theory of automorphic functions, the theory of expansions convergent within a given region, and the theory of summable series.

All the indications seem to point to the conclusion that pure mathematics is in the process of its natural evolution returning to the old path, and that a new phase of advance in the analysis of differential equations and functions is about to come upon us.

But though the same, it will be changed; the work of the last fifty years has given rise to ideas and methods the application of which must necessarily extend the older subjects in altogether new directions, and perhaps lead to an era worthy to be compared with that of Euler and Lagrange.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Joule studentship, founded "to assist research, especially among younger men, in those branches of physical science more immediately connected with Joule's work," will shortly become vacant through the termination of the tenure of Dr. Ulrich Behn, who was nominated by the K. Akademie der Wissenschaften of Berlin in 1901. On this occasion the nomination of a student rests with the president and council of the Royal Society, who will make their selection in October next. The studentship is of the value of 100*l*. in all. Information may be obtained from the assistant secretary of the Royal Society.

WE regret to see the announcement of the death of Sir Joshua Fitch at the age of seventy-nine. The country has thus lost one of its foremost authorities on educational theory and practice. Sir Joshua Fitch was for thirty-one years connected with the Education Department, and the wide and varied experience which he acquired give exceptional weight to his views on educational subjects, expressed in many articles, books and addresses. Since his retirement from official life in 1894, he has taken an active part in the formation of sound public opinion upon educational questions. He recognised that the important point to bring before the people was "that education ought to be a national concern, that it should not be left entirely to local, or private, or irresponsible initiative." This principle must be accepted before any substantial provision will be made for educational progress. Sir Joshua took an active part in the reorganisation of the University of London as a teaching university, and throughout his career identified himself with movements which had for their object the coordination and development of the educational forces of the country.

OF the Education Vote of 11,249,806*l*. agreed to by Committee of the House of Commons last Thursday, only half a million belongs to secondary education. In the course of a speech made in introducing the vote, Sir William Anson expressed the fear that the traditional educational work was being destroyed, and was not being replaced with anything of a really substantial character. He was especially alarmed at the condition of the smaller grammar schools. "In these schools much attention is now being given to science, with results that are not altogether satisfactory. The classical languages are almost disregarded, and history and geography are neglected." Mr. Balfour spoke to much the same effect in the speech at the Allied Colonial Universities dinner which appears in another part of this issue. The suggestion is that science is not such a good educational instrument as the study of dead languages. It does not need much consideration to see that these conclusions are unsound. For centuries our grammar schools have been training grounds for teachers of Greek and Latin, and it would be strange if efficient methods had not been evolved. Every encouragement has been given to the humanities both in school and university, and the masters who have controlled the curriculum or guided the studies have been, with rare exceptions, men distinguished for

their attainments in classical fields. It is scarcely too much to say that few of these men have welcomed the introduction of science into the school curriculum. But, for the sake of recognition by county councils, and the consequent grants, science has been given a place in grammar schools as a paying guest. In many cases the headmasters know nothing of science, and care less; and the teachers in charge of the science work receive little encouragement to do anything but push on promising pupils to scholarship examinations. It is, of course, impossible to discover the educational value of scientific studies under these conditions, when no provision has been made for the supply of qualified teachers, and while the idea still prevails among many masters that text-books and lectures are the most important means of imparting scientific knowledge. It would be strange if the results of such teaching were satisfactory. If Mr. Balfour and Sir William Anson will examine the matter a little more closely, they will see that no fair comparison can yet be made between the merits of classical and scientific studies. Everything depends upon the method by which the subject is taught, and the spirit which inspires the teacher.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 14.—"The 'Elasmometer,' a New Form of Interference Apparatus for the Determination of the Elasticity of Solid Substances." By A. E. H. **Tutton**, D.Sc., F.R.S.

The apparatus is designed to measure the amount of bending suffered by a thin plate of the substance investigated, when supported near its ends against a pair of platinum-iridium knife-edges, under a known weight applied at its centre. It consists of an elaborate apparatus for the support and adjustment of the plate and knife-edges; a measuring microscope, reading in two rectangular directions by a new method to the thousandth of a millimetre, for measuring the dimensions of the plate *in situ*; a specially constructed form of balance, one end of the beam of which carries an agate point, through which a pressure is applied under the centre of the plate equal to the weight in a pan suspended from the other end; a delicate control apparatus, which only permits the weight to operate extremely slowly; an interference apparatus, of which the two reflecting surfaces concerned in the interference are (1) the lower surface of a colourless glass disc supported on a tripod in rigid connection with the knife-edges, and (2) the upper surface of a smaller black glass disc forming the top of a counterpoised rocker, arranged to move with the centre of the plate and thus to transmit its motion. The amount of diminution in the thickness of the air film between the two glass surfaces, consequent on the bending of the plate, is given by the number of interference bands which pass the centre of reference, as seen in the micrometer eye-piece of the observing apparatus, multiplied by half the wave-length of the G or F hydrogen light which is employed. The optical apparatus of the dilatometer previously exhibited is utilised for the transmission of the hydrogen light to the interference apparatus, and as observing apparatus.

June 18.—"On the Discharge of Electricity from Hot Platinum." By Harold A. **Wilson**, D.Sc., B.A., Fellow of Trinity College, Cambridge. Communicated by C. T. R. Wilson, F.R.S.

This paper contains an account of a series of experiments on the discharge of electricity from hot platinum wires. The main object of the investigation was to determine the influence exerted by the nature of the gas in which the wire is immersed.

It was found that the presence of traces of hydrogen in the wire enormously increases the leak of negative electricity from it. By taking precautions to remove hydrogen the negative leak was diminished to one part in 250,000 of its usual value. The presence of traces of phosphorus pentoxide was found enormously to increase the negative leak, and it is known that alkali salts have a similar effect. The results obtained lead to the conclusion that the negative leak is due to the presence of traces of hydrogen, or possibly other substances, in the wire.

With a particular wire in air, the small negative leak remaining when impurities have been got rid of, as far as possible, only falls off very slowly with time, and its variation with the pressure of the air, the potential difference, and the temperature can be measured.

It is shown that the variation of the negative leak with the air pressure and potential difference is due to the ionisation of the air by collisions of the negative ions leaving the wire with the air molecules. If the P.D. used is too small to produce ionisation by collisions, the leak is independent of the air pressure.

The variation of the negative leak with the temperature is investigated, and a formula which represents it is deduced from thermodynamical considerations.

The negative leak in hydrogen at various pressures is measured and found to increase proportionally to the pressure at low pressures. It is shown that the negative leak depends on the amount of hydrogen occluded by the wire. The following table gives the negative leaks at 1400° C. at several pressures in hydrogen:—

Pressure.	Current per sq. centim.
133·0 mm.	$1{\cdot}0\times10^{-3}$ ampere.
0·112 ,, ...	$1{\cdot}2\times10^{-5}$,,
0·0013 ,, ...	$2{\cdot}0\times10^{-7}$,,
0·0 ,, ...	$1{\cdot}2\times10^{-10}$,,

The energy required for the production of a gram molecular weight of negative ions is found to have the following values:—

(1) Thoroughly clean wire in air or vacuum	155,000 calories.
(2) Cleaned wire in air or vacuum.	131,100 ,,
(3) Wire in H_2 at 0·0013 mm. ...	120,000 ,,
(4) ,, ,, 0·112 ,, ...	85,900 ,,
(5) ,, ,, 133·0 ,, ...	36,000 ,,

The paper also contains measurements of the positive leak. It is shown that there is no positive leak appreciable on a galvanometer from a clean wire in a vacuum. In air or hydrogen there is a positive leak, which increases with the gas pressure, and which is probably due to ionisation of the gas molecules in contact with the hot platinum.

It is probable that a pure platinum wire heated in a perfect vacuum would not discharge any electricity at all, either positive or negative, to an extent appreciable on a galvanometer.

"Upon the Bactericidal Action of some Ultra-violet Radiations as Produced by the Continuous-current Arc." By J. E. **Barnard** and H. de R. **Morgan**. Communicated by Sir Henry Roscoe, F.R.S.

The experiments described were carried out with the object of determining the effect on the vitality of bacteria, as the result of exposure to the arc spectra of carbon and of various metals.

The organisms experimented with have been the *Bacillus coli communis*, *B. prodigiosus*, *B. subtilis*, *Micrococcus tetragenus*, *Staphylococcus aureus* and *Bacillus tuberculosis*.

The conclusion arrived at is that the bactericidal action of light is almost entirely due to the action of those radiations in the ultra-violet region of the spectrum which are included between the wave-lengths 3287 and 2265. It is, therefore, necessary that any source of light used as a bactericidal agent should be rich in these rays.

Royal Meteorological Society, June 17.—Captain D. Wilson-Barker, president, in the chair.—Dr. W. N. **Shaw**, F.R.S., read a paper on the meteorological aspects of the storm of February 26–27. Between sunset of February 26 and noon of February 27, the British Isles were visited by a storm of unusual severity. Its most impressive characteristic was the amount of damage done to trees and buildings by gales from the south or south-west, particularly in the neighbourhood of Dublin, where very large numbers of trees were uprooted, and in Lancashire. Gales or strong winds were also experienced in many parts of the British Isles. Dr. Shaw exhibited lantern slides showing the path of the barometric minimum and the area over which the destruction extended. He also put forward some general considerations about barometric depressions and storms, dealing more especially with the distribution of winds and

the velocity of travel, and concluded by making some remarks on self-recording instruments and their management.—A paper by Mr. J. **Baxendell**, on the Dines-Baxendell anemograph and the dial pattern non-oscillating pressure-plate anemometer, was read by the secretary. The Dines pressure-tube anemometer is now the accepted standard instrument for recording wind movement, but it does not record the direction of the wind. Mr. Baxendell has endeavoured to overcome this drawback, and in this paper he gives a description of the combined velocity and direction anemometer which he has designed for the Fernley Observatory at Southport. In addition, he has designed a non-oscillating pressure-plate for showing on a dial the maximum pressure of the wind. By using a combined "head" or vane for the Dines anemometer, Mr. Baxendell has been able to arrange for the new instrument to record (1) the velocity, (2) the direction, and (3) the maximum pressure of the wind.

Linnean Society, June 18.—Prof. S. H. Vines, F.R.S., president, in the chair.—New Chinese plants, by Mr. S. T. **Dunn**. In this, descriptions of more than seventy new species are given, founded on specimens collected chiefly in Yunnan by Dr. A. Henry and Mr. E. H. Wilson.—The germination of the seeds of *Davidia involucrata*, by Mr. W. Botting **Hemsley**, F.R.S. The fruit has an exceedingly hard, bony endocarp or "stone," enclosing usually a number of seeds, and causing wonder how they can free themselves for germination. Under the influence of moisture, a portion of the back of each cell (carpel) separates and falls away in the form of a valve or shutter, revealing a portion of the seed. The radicle soon begins to grow, and in due time reaches the ground, when the upper part of the plantlet frees itself and commences an independent existence.—Rudimentary horns in horses, by Dr. G. W. **Eustace**. Two thoroughbred horses showed bilateral osseous prominences, casts of which were shown; in both the left or near boss is the larger. The occurrence of these is extremely rare, but the pedigree of all known instances being traced back, it is found that they are all descended from the Darly Arabian, bought at Aleppo, and shipped to England in 1705; further, all are descended from Eclipse. The only reference to this phenomenon is that noted by Darwin, "Variation of Animals and Plants," vol. i. p. 52. The author shows that these bosses are not mere exostoses due to disease, and draws the conclusion that they are instances of the reappearance, in a rudimentary condition, of structures which once existed in a functionally perfect condition.—Scottish fresh-water plankton, part i., by Mr. W. **West** and Prof. G. S. **West**. The paper deals with plankton-material from lochs in different parts of Scotland and the Outer Hebrides. The Scottish plankton is found to differ considerably from that of the western part of continental Europe; it is remarkably rich in Desmids, which are of a distinctly western type, and the most abundant are species of Staurastrum. The scarcity of free-swimming Protococcoideæ is striking, but Diatoms are fairly represented. A noteworthy feature is that both Diatoms and Desmids display long spines or processes; this excessive development is ascribed by the authors to the assumption of a purely free-swimming habit.—On the anatomy of the leaves of British grasses, by Mr. L. **Lewton-Brain**. The paper is the result of testing the classification of leaf-structure devised by Prof. Marshall Ward. Four main types are recognised:—(1) leaves in which the upper surface is flat or nearly so; (2) the upper surface marked by distinct though not very high ribs; (3) the upper surface marked by very distinct and high ribs; and (4) the upper surface reduced to a mere fold in an almost solid leaf.

Geological Society, June 24.—Sir Archibald Geikie, F.R.S., vice-president, in the chair.—On a transported mass of Ampthill Clay in the Boulder-clay at Biggleswade (Bedfordshire), by Mr. Henry **Home**. Under 10½ feet of soil and Boulder-clay, the Ampthill Clay was penetrated for 67 feet, resting on Chalky Boulder-clay, fine silty clay, disturbed Gault, and Lower Greensand. The clay is lithologically identical with the Ampthill Clay with its selenite-crystals, and contains *Ammonites excavatus*, often covered with Serpulæ, but no abundant examples of *Ostrea deltoidea*. The boulder was probably an outlier, situated in Oxford Clay at a level high enough to be ploughed into by the agent which formed the Glacial Drift.—The Rhætic and Lower Lias of Sedbury Cliff, near Chepstow, by Mr. Linsdall **Richardson**. The chief portion of the cliff-section described has a direction north-east and south-west; the dip of the beds does not exceed 3° to the south-south-east.—Notes on the lowest beds of the Lower Lias at Sedbury Cliff, by Mr. Arthur **Vaughan**. The two chief points of interest of this section are, the relation of the basal conglomerate to the Cotham Marble and White Lias of neighbouring districts, and the examination of the faunal sequence, with a view of testing the absolute value of ammonite-zones. A diagram is given showing the times of appearance and disappearance, the abundance or rarity, of several fossils within and below the zone of *Ammonites psilonotus*, and on account of the beginning of five forms at a given horizon and the disappearance of several forms immediately below it, this level is chosen as the base of the zone of *A. psilonotus*, rather than the point of appearance of *A. planorbis*, 4 feet higher up. It is hoped that the construction of similar diagrams will be of use in testing the value of a series of ammonite-ages as divisions of relative time.

DUBLIN.

Royal Dublin Society, June 16.—Prof. J. M. Purser in the chair.—Prof. T. **Johnson** and Miss M. C. **Knowles** gave an account of the contents of the British herbarium of the late H. C. Levinge, which had been given to the National Museum in Dublin. The collection contains specimens of nearly all the species of flowering plants and ferns recorded for Ireland; it is especially rich in Westmeath plants, and supplies many additions to the records of Irish topographical botany. Mr. Levinge's herbarium of ferns, British and foreign—4000 sheets—had been previously given to the museum.—Prof. J. A. **McClelland** read a paper on ionisation in atmospheric air. This paper deals with the amount of ionisation in free atmospheric air, and the variations of the ionisation at different times. The largest values have been obtained after several hours' continuous rain, which would agree with the known radio-activity of freshly fallen rain. On the other hand, very small values of the ionisation have been found after slight showers, probably because the ions have been removed from the atmosphere by the condensation on them of water vapour.—Dr. Henry H. **Dixon** showed a model for illustrating the part played by the mesophyll cells in transpiration. The model consists of a funnel closed above by two membranes, between which is a lenticular space containing a sugar solution. The funnel and its stem are filled with water, and, when set in an upright position, are supplied with water through a capillary tube. The motion of water in this tube is made apparent by microscopically observing a precipitate suspended in it. In the paper the working of the model is explained, and it is pointed out that the tension set up by evaporation from the surface of the leaf-cells is transmitted, through the solvent in them, to the water in the conducting tracts of the plant, while at the same time the dissolved substances exert an osmotic pressure and keep the cells turgid. The paper also contains the description of an experiment by which the solvent of osmotic cells may be subjected to tension while at the same time the pressure exerted by the solute is apparent.—Prof. A. W. **Conway** read a paper on a new foundation for electro-dynamics; a modification of the scheme of Helmholtz was proposed in it, the scalar and vector potentials being multiplied by a factor showing Döppler effect.—Mr. J. T. **Jackson** described a new method of producing tension in liquids; how ordinary tap water, just as drawn from the city supply mains, had been subjected to a tension of 38lb. per square inch. Advantage was taken of the principle underlying the working of the common filter pump, Venturi water-meter, spray distributor, &c. The water was forced through a glass tube constricted at one point, and the pressure at the constriction was estimated to fall below two and a half atmospheres negative.

Royal Irish Academy, June 22.—Prof. R. Atkinson, president, in the chair.—On the synthesis of glycosides—some derivatives of arabinose, by Prof. Hugh **Ryan** and Mr. George **Ebrill**. Following the method employed by Ryan

for the synthesis of glycosides (*Jour.* Chem. Soc., 1899, p. 1054; 1901, p. 704), the authors have obtained from the acetochloroarabinose previously prepared by Ryan and Mills (*loc. cit.*) methyl-arabinoside, β-naphthylarabinoside, *o*-cresyl-arabinoside, and carvacryl-arabinoside.—Report on the metamorphosed sedimentary and igneous rocks of the Ox Mountain range in Mayo and Sligo, and of their being probably a continuation of the similar rocks to the west in Mayo and Galway, also that they most likely extend northwards into Donegal and Londonderry, by Mr. A. **McHenry.** Opinions were stated as to the probability that the igneous rocks were contemporaneous in age with the granitic and associated basic rocks of Leinster; that is, that they belong probably to early Devonian time. Also that the sediments into which the igneous rocks of the west and north-west intrude are mainly of Ordovician age, with occasionally Upper Silurian sediments included, as in the case of the Wenlock quartzite of Croagh Patrick Mountain, south of Clew Bay.—On the antipodal relations of the eruptions and earthquakes reported as having occurred since January, 1901, by Prof. J. P. **O'Reilly.** The paper details the principal earthquakes and eruptions mentioned as having taken place since the commencement of 1901, giving the essential particulars regarding the points cited, as also the antipodal relations in each case. It is stated that of the centres of eruption mentioned, between 91 and 92 per cent. lie in the northern hemisphere, giving rise, therefore, to antipodes situated in the southern hemisphere, and for the most part in the Pacific and South Pacific, in the neighbourhood of New Zealand, in the Indian Ocean and the island groups of these oceans, that is to say, in parts of the earth's surface usually considered as being in a state of continued immersion, and so far implying a certain connection between the seats of activity on land and their antipodals in these oceans.—To obtain the cubic curve having three given conics as polar conics, by Dr. J. P. **Johnston.** It was shown that the conditions that the three conics could be transformed by a linear substitution, so as to be the first deriveds of a ternary cubic, gave eight independent linear equations to determine the nine constants of the transformation. A method was then given by which the equation of the cubic could be at once written down in a short symmetrical form. The constants of transformation were seen to be the coordinates of the points of which the conics were the polar conics.—A report on the Irish Hepaticæ, by Mr. D. **McArdle,** forms a *résumé* of all papers on the subject since 1876. 170 species and 63 varieties are enumerated. The arrangement is the same as that adopted in the "Cybele Hibernica," of which it is intended to form part ii. A table of districts shows at a glance the rarity or frequency of each plant.

PARIS.

Academy of Sciences, July 6.—M. Mascart in the chair.—The secretary announced to the Academy the death of Prof. J. W. Gibbs, correspondant for the section of mechanics. (An obituary notice appeared in NATURE of May 7, p. 11.)—Study of the flow of sheets of water, by M. J. **Boussinesq.**—On new syntheses effected by means of molecules containing the methylene group associated with one or two negative radicles. The action of epichlorhydrin upon the sodium derivatives of acetone-dicarboxylic esters, by MM. A. **Haller** and F. **March.** The lactone obtained as the result of this reaction has been esterified with alcohol and hydrochloric acid. The ester was not isolated, since it suffers internal condensation, giving rise to a hydrofurfurane derivative, the properties and reactions of which are described.—The action of human serum upon the Trypanosomes of nagana, caderas, and surra, by M. A. **Laveran.** Human serum, injected into animals suffering from nagana, surra, or caderas, causes the temporary disappearance of the parasites from the blood of the animal. No other method of treatment has been found which causes even a temporary cure of these diseases. No other species of animal furnishes a serum having properties analogous in this respect to human serum, with the exception of a slight effect noticed in the serum from the ape.—Remarks on the formation of pollen in the Asclepiadeæ, by M. L. **Guignard.**—On a rapid method of obtaining a plan of a country by means of photographs taken from a balloon, by M. **Laussedat.** Maps taken photographically from balloons have hitherto required a laborious graphical treatment to reduce them to a plane; a purely optical method of treatment is now described.—Experiments on the resistance of the air, by M. G. **Eiffel.** A heavy mass, 120 kilogrammes, and carrying plates which could be varied in shape and size, as well as means of recording the velocity and air pressure, was allowed to fall freely. The formula usually given for the pressure is KSV^2, where S is the surface, V the velocity, and K a constant 0·125kg. As a result of these experiments, it was found that K increased with the surface, and with equal surfaces, increases with the perimeter p, such that $K=0{\cdot}032+0{\cdot}022\,p$.—Secular variations of secondary importance, by M. Jean **Mascart.**—On the lines of curvature of certain surfaces, by M. E. **Blutel.**—On the groups of Mathieu, by M. **de Séguier.**—On the fundamental functions of Poincaré and the method of Neumann for a frontier composed of curvilinear polygons, by M. S. **Zaremba.**—On the characteristics of the vowels, the vocal scales, and their intervals, by M. l'abbé **Rousselot.**—On a species of oscillation of the chromatic perception, by M. C. **Maltézos.**—Consequences of the theory of nickel steels, by M. C.-E. **Guillaume.** The theory that the anomalous behaviour of nickel steels is due to the transformation of iron from the α to the γ state, and inversely, is applied to the explanation of experiments by Howe, Nagaoka and Honda, and Curie with satisfactory results.—On the diminution of the potential for any spontaneous change in a medium at constant temperature and pressure, by M. **Ariès.**—The action of iodine on thin pellicles of copper, by M. **Houllevigue.** It was found as a result of these experiments, that the smallest molecule of copper capable of reacting chemically with the vapour of iodine is of dimensions of the order of 40 μμ. Its weight is of the order of 5×10^{-18} milligrams.—Simplification of the analysis of silicates by the use of formic acid, by M. A. **Leclère.** After opening up the silicate by fusion with an appropriate base, the use of formic acid in the place of nitric acid is recommended in the subsequent separation of the silica and titanium.—On the conditions of production and stability of thiosulphuric acid, by M. J. **Aloy.** Thiosulphuric acid can be produced by the action of an alcoholic solution of sulphur dioxide on sulphur; the presence of alcohol and of neutral salts increases the stability of the acid.—On the esterification of the hydracids, by M. A. **Villiers.**—On dibromo-acetylene, its purification, cryoscopy, and analysis, by M. P. **Lemoult.** By the action of alcoholic potash upon tribromoethylene, and fractionation in the complete absence of oxygen, pure dibromo-acetylene can be obtained. The formula CBr:CBr was established by analysis and cryoscopic determinations in acetic acid solution.—On lactase, by MM. Em. **Bourquelot** and H. **Hérissey.** Lactase and emulsin are probably two distinct ferments, since emulsin without lactase can be obtained from *Aspergillus niger* and *Polyporus sulphureus*, lactase without emulsin from kephir, and the two together in several species of almond.—The action of sodium on carbon tetrachloride and chlorobenzene: formation of triphenylmethane and hexaphenylethane, by M. Jules **Schmidlin.**—The preparation of primary alcohols by means of the corresponding acids, by MM. L. **Bouveault** and G. **Blanc.** The method of reduction previously described, sodium in boiling alcohol, has been extended to other fatty acids. Aromatic acids with the carboxyl group in the ring resist the reduction.—The internal ethylene oxide of β-cyclohexanediol-1.2, and its derivatives, by M. Léon **Brunel.**—On the amount of acids soluble in ether in wines, considered as a means of differentiation, by M. Ch. **Blarez.**—The heat of neutralisation of hydroferrocyanic acid; the heat of formation of its compounds with ether and acetone, by MM. **Chrétien** and **Guinchant.**—On the fatty acids of egg lecithine, by M. H. **Cousin.** It is shown that egg lecithine contains, besides the derivatives of stearic, oleic, and palmitic acids already known, a derivative of linoleic acid.—The intravenous injection of glycerol; the estimation of the glycerol in the blood and its elimination by the urine, by M. Maurice **Nicloux.** Glycerol disappears very rapidly when injected into the blood, and appears in the urine in notable quantity very soon after injection.—The carbohydrates of barley and their transformation in the course

of germination as carried out on the industrial scale, by M. L. **Lindet.**—Researches on the constitution and structure of the cardiac fibres in the lower vertebrates, by M. F. **Marceau.**—On the suprarenal capsule in amphibia, by M. Ed. **Grynfeltt.**—Experimental pathogenetic segmentation in the eggs of *Petromyzon Planeri*, by M. E. **Bataillon.**—The meriphyte in the Cycadaceæ, by M. H. **Matte.**—On two Cephalopod layers of the Upper Devonian in the Sahara, by M. Émile **Haug.** These fossil-bearing layers present remarkable palæontological affinities with the layers of the same age in central Germany.—On the variations of the Meuse at the quaternary epoch, by M. Paul **Bois.**—On the retrogradation of starch, by M. L. **Maquenne.**—On an oxidising bacterium, its action on alcohol and glycerol, by M. R. **Sazerac.** There exists in certain wine vinegars an oxidising bacterium which differs both in its appearance and cultures from the sorbose bacterium, and which is capable of rapidly oxidising glycerol to dioxyacetone. Its acetifying power is very small.—On the production of glucose under the influence of asphyxia by the tissues of *Bombyx mori*, at various phases of its evolution, by M. F. **Maignon.**—On the production of hydrogen sulphide by extracts of organs and albumenoid materials in general, by MM. J. E. **Abelous** and H. **Ribaut.**—Study of the marine circulation, by M. J. **Thoulet.**

New South Wales.

Royal Society, May 6.—Prof. Warren, president, in the chair.—The president delivered an address on the development and progress of engineering during the last twenty-one years. In the course of his address he remarked that the wonderful progress during that time, and the great activity to-day in all branches of science and engineering, suggests great possibilities in the future. All future progress in engineering must depend upon exact knowledge and scientific thought and work. Our systems of primary, secondary, technical, and professional education must be carefully reconsidered in order to bring them up to the needs and requirements of modern civilisation. The engineer of the future must be a still more widely trained and better educated man than his predecessor of to-day, so that he may be better able to solve the many problems which lie before him in the future.

Linnean Society, April 29.—Dr. T. Storie Dixson, president, in the chair.—Australian fungi, new or unrecorded. Decades iii.-iv., by Mr. D. **McAlpine.** Of the fungi here recorded, fifteen are described as new species, fourteen genera being represented. The orchids, which are generally comparatively free from fungi, contribute two, one of the genera (Amerosporium) being new to Australia.—Notes on Australian Rhopalocera: Lycænidæ. Part iii., by Mr. G. A. **Waterhouse.** This part deals fully with the descriptive portion of the subject and with the nomenclature.—The bacterial origin of the gums of the Arabin group, by Dr. R. Greig **Smith.**—On some new or unrecorded species of West Australian plants, by Mr. W. V. **Fitzgerald.** The following are described as new:—(1) Hensmania, gen. nov., founded upon *Xerotes turbinata*, Endl., of which perfect flowers were previously unknown, and of which Mr. Bentham did not see specimens in fruit. (2) Six species referable to the genera Leucopogon, Conostylis, Centrolepis, Restio, Hypolæna and Cyathochæte, and four to Schœnus. Two species, *Anisacantha (Bassia) longicuspis*, F.v.M., and *Stipa Tuckeri*, F.v.M., are now recorded from West Australia for the first time.—The vegetation of New England, N.S.W., by Fred. **Turner.** The New England district lies between 29° and 31° south lat., and 151° 20′ and 152° 20′ east long., and has an average elevation of about 3500 feet. Its flora may be described as intermediate in character between the subtropical and in places very dense and luxuriant vegetation of the coastal strip between its eastern boundary and the sea and that of the plains to the west, consisting of trees and shrubs of a more dwarf habit, and generally with less luxuriant foliage, except near water-courses. The census of the phanerogams and vascular cryptogams now brought forward yields a total of 369 genera and 708 species.

May 27.—Dr. T. Storie Dixson, president, in the chair.—Australian Psyllidæ, part iii., by Mr. W. W. **Froggatt.** Sixteen species are described as new, including three fine gall-making species of Trioza—two from Tasmania, and the third from Queensland, which is remarkable for its curious, open, saucer-like galls, in form approaching those of some of the gall-making Coccids.—On a revision of the Eucalypts of the Rylstone District, N.S.W., by Mr. R. T. **Baker.** In a previous paper twenty-two species of Eucalypts were enumerated. As the result of further collecting and study in the interval, the number of species now recognised has been increased by ten, while some of the earlier determinations have been reconsidered and amended.—A slime bacterium from the peach, almond and cedar (*Bact. persicae*, n.sp.), by Dr. R. Greig **Smith.** The organism produces a slime, the essential carbohydrate of which readily becomes converted to an insoluble modification. The carbohydrate is easily hydrolysed to arabinose and galactose, the latter sugar preponderating. The insolubility of the gummy constituent when heated under pressure shows that it does not belong to the arabin group. The soluble gum is coagulated by the acetates of lead, barium hydrate, milk of lime, and aluminium hydrate. The insoluble modification is easily dissolved by dilute acids, but not by dilute alkali. A small quantity of gum behaving to reagents like the bacterial gum was separated from the natural gum of the almond.

CONTENTS.

PAGE

THURSDAY, JULY 23, 1903.

EXPERIMENTAL MORPHOLOGY.

Willkürliche Entwickelungsänderungen bei Pflanzen. Ein Beitrag zur Physiologie der Entwickelung. By Georg Klebs. Pp. iv + 166. (Jena: G. Fischer, 1903.) Price 4 marks.

THIS is practically a continuation of Dr. Klebs's well-known work "Die Bedingungen der Fortpflanzung bei einigen Algen und Pilzen" (Jena, 1896), but whereas that was concerned with the lower organisms the present work deals with phanerogams. Both works are contributions to experimental morphology, the essential feature in both being the performance of a series of experiments skilfully planned so as to discover the nature of the external conditions which lead to certain definite changes of form or function in plants. Englishmen will be glad to see that to Andrew Knight is given the honour of being the founder of this type of work; then follow Hofmeister, Vöchting, Sachs, Goebel, Bonnier, &c., nor should it be forgotten that Klebs himself has worked steadily and with brilliant effect on this line since 1889.

Klebs's aim is definitely objective; he seeks to discover facts, without regard to whether the changes arising under given conditions are adaptive. He nevertheless allows himself to postulate a certain mechanism in the organism by which he conceives it possible that external conditions produce their effect. His discussion is interesting, but his terminology seems to us open to criticism, nor does his theory strike us as essential to his aim—the foundation of causal morphology in a purely objective sense. He takes, as an instance, the undifferentiated cells in the growing-point of a plant, in which reside the possibility of developing into organs characteristic of the species. The physical substratum in which this potentiality resides he calls "specific structure." This he assumes to be constant, which implies (we imagine) that under certain definite conditions it always develops an identical form, while if the conditions are different the form will be different. Under the heading "conditions" he distinguishes external and internal. He retains the term external as being already in common use, though he seems to prefer the expression "directe oder unmittelbare äussere Bedingungen." These are the various chemic, thermic, photic, and mechanical influences which act on the organism from its earliest stages. The definition of the inner conditions is as follows:—

> "Every phenomenon of life occurs within the organism; it is a consequence of the internal conditions ruling at the moment. The quality and quantity of the substances present in the cell, the various kinds of ferments, the physical properties of the protoplasm, cell-sap, cell-wall, &c., all these belong to the internal conditions,"

and are "in the first instance supplied to the individual by its origin from a previous generation."

He also strongly insists on the internal conditions being completely distinct from the specific structure. We fail to see that a real distinction between internal and external conditions is made good. For instance, a naked protoplast placed in a nutrient fluid—a solution of glycerin—is subjected to new external conditions. But a vegetable cell treated in the same way takes up glycerin into its cell-sap, and by the above definition the physical properties of the cell-sap are internal conditions. Yet in both cases the change consists in exposing protoplasm to a certain solution. Nor again can we clearly distinguish between internal conditions and specific potentiality. In a mechanical theory such as Klebs's the "specific structure" must depend on the physical properties of protoplasm, yet these last named are said to be part of the internal conditions.

All that Klebs proves by his experiments is that a change of external conditions determines a change in the form and physiological processes of the organism. We may conclude from this that the undeveloped tissues are under the rule of changing conditions, but have we a right to draw any other conclusion? Klebs has shown that Saprolegnia grows continuously if supplied with good culture-fluid, but that it at once forms zoosporangia if the culture-fluid is replaced by pure water. The same thing happens if the fungus is left to itself with a limited supply of food, *i.e.* it forms zoosporangia when the nutriment runs short, thus by its own activity it makes the conditions necessary for zoospore formation. Or, what is another way of putting the matter, the artificial exchange of nutrient fluid for pure water induces zoosporangium-formation because it is an imitation of the natural series of changes to which the plant is subject. Klebs does not pretend to say how pure water leads to zoosporangia being formed; he shows it to be a necessary condition, but the causal connection is absolutely unknown. It possibly always will be so, but it is at least possible to give the problem its proper place among cognate questions, *i.e.* those relating to reflexes. These are most conveniently studied in the facts of movement, but there is no reason for excluding the facts of experimental morphology. In our opinion, the purely objective method applied to reflexes is incomplete; we differ markedly from Klebs in thinking it impossible to deal fully with the question without taking adaptiveness into account. The fact that a stem bends upwards when deflected from the vertical, depends on some strain or pressure produced in the protoplasm by such deflection. We call this a stimulus, but only because it precedes the act of curving and by endless repetition is associated with that act. What was originally a physical concomitant of a certain position of the plant in relation to the vertical comes to be a stimulus. It may be said that the primeval plant which acquired geotropism did so because there is some unknown but necessary connection between mechanical strain applied to protoplasm and the act of curving upwards. But if so why are essentially similar plants stimulated to downward curvature by a like strain? Only a vague answer can be made from the objective point of view. From the adaptive point of view there is no difficulty; any curvature may become associated with any physical change in the protoplasm, upon which it normally and continuously follows. The importance of natural selection is here obvious, for it picks out the

plants which have the capacity of association, and which, to speak metaphorically, are able to use changed conditions as signals for serviceable movements. Without selection we cannot conceive the forging of the chain of inherited habit which binds plants to the performance of adaptive movements.

It is true that we cannot say in what the association consists, and it will doubtless be said that our point of view only differs from that of Klebs in substituting "stimulus" for "conditions." The difference is essential, for we take into account natural selection as a universal condition under which all organisms subsist.

We must be content to differ from Dr. Klebs, who goes so far as to say (p. 162) that the adaptation (Zweckmässigkeit) of organisms is in no way (gar nicht) a scientific problem. We are none the less ready to welcome his researches, of which we proceed to give some account.

Among the results obtained by Klebs some of the most interesting are the experiments in which, by appropriate culture conditions, he converts an inflorescence into an ordinary vegetative shoot. For instance, by making a cutting of the flowering shoot of *Veronica chamaedrys* and growing the plants in damp air, he converts an organ of limited growth into one of unlimited growth, with leaves differing in size, character of hair and phyllotaxy from those of the inflorescence, and resembling the ordinary vegetative shoot.

Another interesting series of observations is on *Glechoma hederacea*, which, if grown in a greenhouse and watered with nutritive solution, never flowers, whereas parts of the same individual plant, grown in small pots in summer and kept cool in winter, flower in the following summer. By special treatment he even compelled flowers to appear on the runners, whereas normally only the upright shoots bear flowers. *Ajuga reptans* bears runners in the axils of its rosette-leaves; these form in the autumn new terminal rosettes, the central shoots of which flower in the following spring. This is the normal state of things, but Klebs converted a flowering shoot into a runner by darkness and damp heat, and also produced other curious anomalies of development. In another experiment on the same type he introduced a runner into the lower end of a cylinder of water, when its normally horizontal growth was changed and it grew straight up until it reached the air, where it once more became horizontal. Klebs devotes a section of his book to a discussion of the facts of regeneration for which we are largely indebted to Vöchting. Klebs points out that we do not even know why the severance of a part from its parent should lead to a regenerative outgrowth of roots and shoots; he goes on to demonstrate by experiments that in *Salix vitellina* a branch, without being severed from its parent, can be forced to make roots by submergence in water. He uses this fact as an argument against the adaptive explanation of the behaviour of cuttings. It proves, of course, that some of the phenomena are producible without severance, but the facts of severance remain; two different stimuli may produce the same result, as in the well-known experiment of Pfeffer in which the root-hairs of the gemmæ of Marchantia develop on the physically lower side and also on the side in contact with a solid body.

Another section of the book deals with the length of life of plants and the cognate facts on resting periods in vegetable growth. He shows that Parietaria can be kept in constant flower for two years. That in annuals there is no inherent limit to their development, as he proved by making a series of cuttings of the growing shoots. Again, he compelled the winter buds of Gratiola to germinate (contrary to their habit) without a resting period, by cultivating the plant under water and placing it in a greenhouse in autumn. These may serve as examples of the experimental work in which Dr. Klebs is engaged. It is evidently a research which tests to the full his ingenuity and determination, and it is one in which all naturalists will wish him the success he deserves.

The book concludes with a section on "Variation and Mutation," which will be useful to old-fashioned evolutionists in showing the trend of certain younger schools of thought.

FRANCIS DARWIN.

NITROGEN AND ITS COMPOUNDS.

Der Stickstoff und seine wichtigsten Verbindungen. By Dr. Leopold Spiegel. Pp. xii+912. (Braunschweig: Vieweg und Sohn, 1903.) Price 20 marks.

THE large and ever-increasing amount of work turned out by research chemists in all branches and departments of the science, and the dispersal of the results of investigations throughout a sufficiently extended array of publishing media, awaken the demand for some means by which the wealth of newly-acquired knowledge may be made easily accessible; and the editor or author who undertakes the very tedious but important task of collecting from the different sources and arranging in a summarised form all, or even the most important, facts which have been established, performs a service to his science for which he does not always receive due credit.

The importance of the compounds of nitrogen for the study of valency and the formation of complex compounds, the important position which they occupy in investigations into the laws of stereochemistry, and, in the case of the carbon compounds, the determining influence of the nitrogen atom on the character of the molecule, have led the author to the compilation of a volume which brings together all the most important known facts with regard to the chemical and physicochemical relationships of this element and its compounds. No separation is made of the organic from the inorganic compounds, but the latter are treated much more fully than the former. With regard to the organic compounds of nitrogen, the author has wisely refrained from a duplication of "Beilstein," and has contented himself with pointing out the more important characteristics, and with giving in tabular form the chief representatives of the different groups.

The whole matter is arranged under the following headings:—the element, halogen compounds of nitrogen, oxygen compounds of nitrogen, sulphur compounds of nitrogen, hydrogen compounds of

nitrogen, metal nitrides, phosphorus compounds of nitrogen, arsenic nitride, carbon compounds of nitrogen, silicon nitride, titanium compounds of nitrogen, zirconium nitride, boron compounds of nitrogen, nitrogen in closed rings, alkaloids, protein substances, analytical methods, addenda.

The treatment of the element and its important inorganic compounds, *e.g.* nitric acid and ammonia, seems very satisfactory, although, for instance, the action of hypobromite on ammonium chloride might well have been included in the list of methods of preparing nitrogen, instead of merely being referred to incidentally in another connection.

Apparently no attempt has been made to sift critically the large accumulation of material at the author's disposal, and the book therefore assumes the character of a dictionary. Nevertheless, several cases are to be found where a more connected treatment is given to the subject, as, *e.g.* in the description of the steps by which the formation of nitric acid in the soil was traced to a specific ferment, or in the account of the application of Werner's theories to the constitution of the metal ammonia compounds. Such accounts, although written in briefest outline, serve to direct attention to points of importance in theoretical chemistry. The account of the diazo-compounds one could wish fuller, and some reference might have been expected to Goldschmidt's important work on the dynamics of the diazo- and azo-compounds. In mentioning the transformation of ammonium thiocyanate (the melting point of which is 149°, not 159°) into thio-urea, also, the work of Waddell might have been referred to. Further, in the analytical portion of the book, although various methods are given for the estimation of nitrogen in organic compounds, no mention is made of the Frankland-Armstrong modification of Dumas's method, although it is probably the most convenient and accurate method of estimation.

In compiling the book, the chemical literature up to 1900 has been taken into account; and in an appendix additions and corrections are given bringing the work up to 1902. In spite of some omissions, the book will be readily welcomed as an important addition to the works of reference in chemistry, and the author deserves the thanks of his fellow-workers for the trouble he has taken in the compilation. A. F.

PROSPECTING.

La Prospection des Mines et leur Mise en valeur. By Maurice Lecomte-Denis. Pp. xv+551, with 320 figures. (Paris: Schleicher, 1903.)

WHEN an author is fortunate enough to have such a godfather for his book as M. Haton de la Goupillière, it may be taken for granted that the work contains much useful matter. The book is intended not so much for the old-time prospector, armed with pick, shovel, and pan, who wanders about in search of gold, as for the scientific mining engineer called upon to report upon a mineral deposit already discovered, and possibly already worked on a small scale. M. Lecomte-Denis tells the novice how to set about his work, and how to draw up his report to his employers, and he points out useful precautions to be observed in purchasing mines and minerals. The motto for the chapter upon "salting," "*Défiance est mère de sûreté,*" is well chosen; many of the common tricks of fraudulent mine-vendors are exposed by the author, who most wisely advises the inspecting engineer to err on the side of scepticism when making his examinations.

Next come two purely geological chapters upon the distinctive characters of the igneous and of the sedimentary rocks. It is doubtful whether it is wise to burden a book upon prospecting with more than three hundred figures of fossils. M. Lecomte-Denis points out, however, that the traveller cannot carry a geological library with him, and that it will probably be a convenience to him to possess a little palæontological information for immediate reference on the spot.

Six chapters are devoted to the study of the modes of occurrence of the most important useful minerals, viz., coal, petroleum, bitumen, and the ores of iron, copper, zinc, and lead. Many useful commercial data are appended. Similar information concerning phosphates, bauxite, and the ores of tin, mercury, &c., is promised in a later edition.

When a mineral deposit has been found, it is usually necessary to investigate its commercial value by certain preliminary workings. The manner of carrying these out and of making deductions from the results obtained is treated in a long and useful chapter. The author speaks wisely with regard to writing reports when he bids the engineer weigh his words very carefully, for extracts may be made, and words may be twisted, so as to convey a meaning very different from that which was intended. The greatest prudence is necessary on the part of inspecting engineers with the object of not raising his employer's hopes too high, nor, on the other hand, by an unnecessarily pessimistic tone, of preventing him from embarking upon an undertaking which may have many chances of success. What is required is complete frankness; let the capitalist know the grounds upon which the engineer bases his opinions. If the former is in doubt, he can then go to a consulting mining engineer and say, "Supposing these data to be true, what is your advice?"

The inspecting engineer should certainly make himself acquainted with the mining laws of the country in which the property upon which he is reporting is situated; and the brief remarks of M. Lecomte-Denis upon foreign mining jurisprudence may serve as a first step in the study. On the other hand, more space is devoted to an exposition of the mining laws of France than seems to be necessary.

The tables at the end of the book are similar to those found in the usual miners' pocket-books. Some palpable errors show that sufficient care was not taken in preparing them for the press, and consequently the reader may feel a little sceptical about their trustworthiness. On the whole the book is likely to prove useful to the mining engineer, for it deals with matters which are usually considered somewhat outside the scope of the ordinary text-books.

OUR BOOK SHELF.

The Revival of Phrenology. The Mental Functions of the Brain. By Bernard Hollander, M.D., &c. Pp. xviii + 512; illustrated. (London: Grant Richards. 1901.) Price 21*s*. net.

According to Dr. Hollander, the connection between mind and brain has long been waiting for a discoverer, and he is determined that it shall wait no longer. "The present work aims at clearing up the mystery of the fundamental psychical functions and their localisation in the brain. It is the first work on the subject since the dawn of modern scientific research." We expect that an author who claims to clear up a mystery and to write the first work on a subject since the dawn of scientific research should at least be acquainted with the present position of the science with which he deals, but we do not find that Dr. Hollander has satisfied this preliminary requirement. The very title of his book indicates that he is not before, but behind the age. Mental phenomena are not functions of the brain in the modern medical meaning of the term "function," and if by "the fundamental psychical functions" Dr. Hollander means the primary divisions of mind as recognised in modern psychology, then we cannot find evidence in his book that he knows what they are. "Most men," he says, "regard mind as though the term were equivalent to intellect and did not include the feelings and fundamental impulses." "The great majority hold mind to be equivalent to intellect." We do not know whether by "most men" and "the great majority" Dr. Hollander means the majority of the whole population, or of the whole male population, or of neurologists, or of psychologists. If he means either of the two former, he is probably wrong. If he means either of the two latter, he is certainly wrong; so wrong that it is difficult to believe that he has opened a book on psychology that has been published within the last half-century. When a writer presumes to lecture the whole world of psychologists in the tone of the Supreme Being addressing a group of blackbeetles, he should at least make himself acquainted with the rudiments of their terminology. He would then avoid speaking of "faculties" as "forces." He would not say that "satisfaction, discontent, desire, fear, anger . . . &c., are so many states of our internal organisation which . . . exist . . . without consciousness . . . being necessary."

"The data amassed by the author," Dr. Hollander modestly asserts, "are so considerable as to open up quite a new field for research." These data consist of more than 800 cases, which are alleged to illustrate the connection between some special brain-area and some special phase of mind. The first group are "cases of melancholia due to injury to the central parietal area." A number of cases of injury to the parietal region are adduced, but in many of them there is little or no evidence of melancholia. Whenever, in the reports, the word depression is used, Dr. Hollander accepts it as the equivalent of melancholia, though it is quite obvious that in many cases it means hebetude, stupor or coma. Melancholia is attributed to blows on the parietal region that were inflicted four years, five years, six years, fourteen years, seventeen years before the patient came under treatment. Of the innumerable multitudes of cases of lesion of the parietal region without any sign of melancholia resulting, not a word is said. This is not scientific investigation; it is special pleading. Dr. Hollander pleads that in view of the important bearing of his facts upon the entire development of medical science, on the study and treatment of lunacy, on the education of the young, &c., the evidence and statements may be received willingly and in fair spirit, however critical. We have endeavoured to comply with his request. We have weighed his evidence, and it seems to be of the same value as his statements.

St. Kilda and its Birds. By J. Wiglesworth. Pp. 69; illustrated. (Liverpool: C. Tinling and Co., 1903.)

On his return from an ornithological trip to the St. Kilda group last summer, Dr. Wiglesworth delivered before the Liverpool Biological Society a lecture on these islands and their inhabitants—human and otherwise. This lecture has been published in the volume before us, and although the author has little or nothing absolutely new to tell, he has undoubtedly succeeded in producing a very interesting work, which ought to be invaluable to all future tourists in these islands. Although the extension of the breeding range of the fulmar-petrel to the Shetlands has deprived St. Kilda of one of its claims to preeminence, yet it possesses an absolutely peculiar form of wren as well as two mice of its own, while it is also one of the chief breeding-places of the fork-tailed petrel. Moreover, its breeding-list of other sea-birds is comparatively large, so that the island possesses especial interest for the ornithologist and egg-collector. Unfortunately, the latter individual has of late years made himself somewhat too conspicuous, and "when it comes to dealers giving unlimited orders for fork-tailed petrels' eggs at prices which set the whole male population of the island on the alert to dig out every petrel-burrow they can possibly come across, one cannot but feel considerable anxiety as to the future of this interesting species." High prices are likewise paid for the eggs of the St. Kilda wren, of which large numbers are exported. It would therefore seem that the island stands in urgent need of the special attention of those interested in bird preservation. One of the features of St. Kilda is the number of species of petrels by which it is inhabited, while not less noteworthy are the hordes of puffins which swarm over its grassy slopes, and tenant almost every available nook amongst the rocks and boulders.

But it is not only for its birds and mice that the St. Kilda group has a special claim on the interest of the naturalist. One of the islets, Soa, or Soay, is remarkable as being the only locality in Great Britain where sheep exist in a wild condition. It appears that in the latter part of the eighteenth century the owner of St. Kilda laid claim to one out of every seven sheep born in the main island. These sheep were carried to Soa, where, in the absence of anyone to look after them, they ran completely wild. And by this accident has been preserved to our own time the very small and peculiar breed of sheep which was probably once common to St. Kilda and most of the western islands, but has everywhere, except in Soa, been modified by the introduction of other breeds. Most of these sheep are light brown in colour, although a few are almost black, and others nearly white. They are so wild and shy that they cannot be approached within 100 yards, except by careful stalking, while their activity and speed are such that they cannot be hunted down by the dogs of the islanders. A ewe of this sheep, as well as the skull of a ram, are exhibited in the Natural History Museum. R. L.

The Principal Species of Wood. By C. H. Snow, C.E., Sc.D. Pp. xi + 203. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 15*s*. net.

In producing this work the author has evidently spared himself no pains to collect a vast amount of statistics concerning the genera and species with which he deals. The work is also profusely illustrated by plates, and these, along with the general equipment of the book, reflect credit on artist and publishers. Tabulated statements concerning the different species are given, and contain data such as modulus of elasticity and rupture of wood, as well as notes on its various struc-

tural qualities and representative uses. These will prove of value to both expert and amateur.

From its title one might be led to suppose that the book was an addition to the literature of strict forest botany, but the preface states that "It is intended for those who are not foresters or botanists, but who use woods or desire a knowledge of their distinguishing properties." The preface further states that "Although great care has been taken to check each fact, errors no doubt exist, although it is not believed that there are important ones." We cannot entirely agree with the author in this. For example, in the introduction we are told that a true wood fibre originates from several cells, "a resin duct is a cell structure or a fibre," "a vessel is a short wide tube joined vertically end to end with others of its kind."

Inaccuracy and vagueness of expression are to be found elsewhere in the book. For instance, "Europeans regard the Ash for ornamental purposes, but Americans value it for wood" is an error that may perhaps be excused in an American writer, but why should the leaves of Eucalyptus be described thus?—"Those of young blue gums are bright blue, oval and stalkless, while leaves of older trees have stems (*sic*), are dark green and sickle-shaped."

Attention is further directed in the preface to the fact that "Allusions to trees, historical and other references, aside from those directly regarding woods, are made for completeness and in order to mark, distinguish, or separate the species." The author fails to realise this object. The distinguishing characters given are far too vague and general to be of any practical value.

On the whole the book contains much useful information and statistics regarding the various species of wood, both broad-leaved and coniferous. It would have been much better, however, had the author confined himself to the treatment of this aspect of the subject alone, leaving out all botanical and other technical matter.

Lehrbuch der Mikrophotographie. By Dr. Carl Kaiserling. Pp. viii + 179. (Berlin: Gustav Schmidt, n.d.) Price 4 marks.

ALTHOUGH there are several well-known treatises on this subject, it is doubtful whether any exceed in thoroughness the one now under notice. The essential conditions for the production of photomicrographs of the highest class are carefully described, and each part of the process is treated fully.

There is no more important point than the illumination of the object itself, and both the source of light and its colour should be selected to bring out the desired points in the resulting photographs.

This part of the subject is generally treated all too briefly, but in the present instance its importance is evidently recognised. The various ways of making light filters and their use with coloured preparations are described. The method of arriving at the proper filter to use with a given preparation is stated to be by determining the absorption spectrum of the dye used for staining, by aid of a hand spectroscope, and then adapting the light filter to give the result desired. This is undoubtedly the only scientific method of using colour screens in photomicrography, and one which we have adopted with success for some time past.

The various types of apparatus by the leading makers are fully described, prominence being naturally given to continental firms. Instructions as to the use of substage apparatus, methods of centring, choice of objectives, and the combination of microscope and camera are included, while it is satisfactory to note that no space is unnecessarily wasted over purely photographic processes. Altogether the book may be recommended to photomicrographers as one of the best yet published. J. E. B.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Source of Radium Energy.

THE novel and unforeseen property of radium of producing energy, which purely kinetic theories, in opposition to the notion of inherent force as a transcendental element, do not seem able to explain, is perhaps destined to give a fresh impetus to discussion from the two distinct points of view. It is meanwhile to be noted with regard to this, that the notion of force acting at a distance from point to point, being equal and reciprocal between the various material points, does not appear to be any better met by the manifestation of the unfailing energy of radium than the simple movements of the kinetic theory. This remark justifies attention being directed to a view of the natural physical forces presented by the present writer more than ten years ago (see Lagrange's "Study of the System of Physical Forces," forming vol. xlviii. of the *Memoirs* of the Royal Academy of Sciences of Belgium). It is there shown that forces exist of such a nature that static equilibrium is impossible, on the impact of bodies of different composition, at their surfaces of contact. They are forces making a body, after the example of radium, emit rays unceasingly without apparent loss of substance. A force of repulsion is referred to here, emanating from the surface, and not from the centre of the mass of atoms, acting on opposed surfaces, and the varying intensity of which is nothing else than what is known to science as absolute temperature. That repulsive force, acting in the inverse ratio of the volume of matter (or of the cube of the distance), just as Newtonian gravitation acts in the inverse ratio of the surface (or as the square of the distance), takes its immediate development, and to some extent visible shape, in Mariotte's law of the relation of pressure to volume in gases. The memoir establishes the existence of a continuous interatomic medium of transcendental qualities not yet understood, conveying the effect of a force acting at the surface of atoms, and the real seat of luminous and electromagnetic wave motion, according to the views to which clearly Lord Kelvin has of late returned. The view now presented is entirely deduced from analysis of the actual facts, worked out at length, and justified by the memoir, and new so far as the case of the impossibility of an equilibrium due to the surface force of repulsion, which gives rise to an exhaustless emission of energy. The reflecting attention of physicists may therefore be legitimately directed to the subject, because it seems certain that the new properties which radium manifests are not explainable by the kinetic hypothesis, but, on the contrary, are of a nature henceforward to modify considerably the speculations of modern physics.

Brussels, July 14. CH. LAGRANGE.

A New Case of Phosphorescence induced by Radium Bromide.

IT is known that salt (NaCl) at a temperature of 200° C. is phosphorescent (*vide* Phipson on "Phosphorescence," p. 20); during a course of experiments in June last I found that radium bromide induces phosphorescence at ordinary temperatures. The following is a convenient way of observing the phenomenon. Fill a wooden match-box with table salt removed from the inner portion of a block; press the radium bromide tube into the yielding mass and just barely cover it with the substance. If it be now put on one side for a few hours, say into one of the compartments of a chest of drawers, on opening the box in the dark all round the tube will be found to phosphoresce with a white light, but, unlike zinc blende and barium platinocyanide, the salt continues visibly to phosphoresce after removal of the radium bromide. The portions of salt round the tube are turned of a faint buff or ochrey tint. The image of the visible portion round and where the radium bromide tube has lain is impressed on a photographic plate in thirty

minutes, but only very faintly in two or three minutes. I have tried samples of salt from several localities with the same results.

WILLIAM ACKROYD.

Tables of Four-figure Logarithms.

I AM much interested by the short letter, contributed by Prof. Perry to NATURE of July 2 (p. 199), on the subject of four-figure logarithms, especially as I have myself offered a solution of the difficulty which Mr. Harrison has essayed to remedy. If, instead of using Bottomley's differences for the upper part of the tables, viz. from 1000 to 1799, we resort to the usual tabular differences found in any ordinary logarithmic tables, such as Chambers's, we get an even greater accuracy than does Mr. Harrison. The tables are naturally weakest when we have a "9" for the fourth figure of the number the logarithm of which is required. Taking this as a test, between 1000 and 1799 the accuracy of the three methods may be expressed thus:—

	Per cent.
Bottomley's differences	37·5
Ditto, Harrison's extension	58·5
Ordinary tabular differences	76

Tabular differences would be required corresponding to logarithmic differences of 43 to 24 inclusive, *i.e.* twenty small columns of differences. It may be objected that it would be unwieldy in use to change from one method of procedure to another, but I think it will be found, also, that Mr. Harrison's tables are not so easy to use as the unmodified ones. The tabular differences might, indeed, be printed down the side of Bottomley's table without disturbing the usual differences, and only be used when the best possible accuracy is desired.

One of the best solutions of the difficulty has been suggested to me by Prof. Perry himself, viz. divide the number, less than 2000, the logarithm of which is wanted, by 2, and add together the logarithms of quotient and divisor. The approximation to the true logarithm of the number is very good.

I cannot agree that chemists, in any case, should use four-figure logarithms, seeing that they habitually return four figures as significant. I hope, before long, to be able to show that practicable five-figure tables can be constructed to which the reproach of "size" will be inapplicable.

July 3. M. WHITE STEVENS.

PROF. PERRY in NATURE of July 2 (p. 198) gives an illustration of a method whereby the logarithms of the numbers from 1000 to 2000 may be got from a four-place logarithm table with an error of, at most, one unit in the last place.

It is, however, somewhat difficult to see what advantage this arrangement has over the one where the logarithms of the numbers 1000 to 2000 are given (again) after 999 *in extenso* without proportional parts.

By this latter system the tables are certainly increased in size by another double page, but, on the other hand, there is a decided disadvantage in using the relatively large proportional parts for the numbers 1000 to 2000. If the addition of the proportional parts is done on paper, time will be lost; if the addition is done mentally, mistakes may easily occur.

C. E. F.

Edinburgh, July 4.

IN mathematical tables the last figure in any tabulated number or difference must be liable to an error $\pm\frac{1}{2}$. When a number is extracted from the tables by aid of a tabulated difference, the result is subject to a duplication of error, that is, to an error ± 1. It will be found on examination that in some of the early numbers of the ordinary four-figure log tables the error is often double this amount. Mr. Harrison's alteration remedies this mistake, and makes the maximum error uniform throughout. The scheme proposed by Mr. Stevens can do no more than this, and would be more clumsy. The figures given by him apparently refer to averages, and are irrelevant.

If the proposal of C.E.F. were adopted, the first portion of the table would have double the accuracy of the remainder; the result of any general calculation would depend on the accuracy of the latter, and little, if anything, would be gained in return for the fact that the space occupied by the tables would be doubled.

JOHN PERRY.

A Multiple Lightning Flash.

I HAVE had the privilege of examining the print of the lightning flash taken by Mr. C. H. Hawkins, of Croydon, and referred to in NATURE (July 16, p. 247) by Dr. W. N. Shaw.

The main flash consists really of *three* flashes, the several paths of which are not quite coincident. If a moving camera had been employed (I assume the camera in this case was fixed), then I think the three flashes would have been easily distinguished. The flash on the right is evidently a ramification of the main stream. Except for the above, the photograph shows no other special features.

WILLIAM J. S. LOCKYER.

Solar Physics Observatory, July 17.

The Lyrids, 1903.

THE return of the Lyrids this year was well observed here. Watching was begun on April 15, and continued until April 24, the series being broken only once, namely on April 20, when the sky was overcast. The weather was very favourable, the heavens on most nights being beautifully clear. Eighty-four meteors were registered, of which twenty were Lyrids.

The chief points with regard to the Lyrids brought out by the observations are:—

(1) The display was of moderate strength.

(2) The maximum occurred on April 21 and 22, probably more precisely at midnight on the latter date.

(3) The decrease in activity was more rapid than the rise to maximum.

(4) The radiant on the nights of April 21–22 was at $271\frac{1}{2}^\circ + 33^\circ$ (12 paths).

(5) The colours of the Lyrids were almost wholly of two shades, white and a peculiar yellowish, dirty-looking green.

(6) The meteors were swift, their average angular velocity being 20° a second, not taking into account those which appeared close to the radiant. The real speed of a Lyrid fireball recorded on April 22 by Prof. Herschel at Slough and the writer at Leicester has been computed to have been 39 miles per second.

(7) Only the very brightest Lyrids left streaks.

The first meteor of the shower was observed on April 17. There was a remarkable break on April 19, when not a single Lyrid was seen in a watch lasting three hours, though the seeing was excellent.

Minor Showers.

Besides the Lyrids, radiants were found for the chief active showers as under:—

Radiant-point	Duration	No. of meteors	Remarks
$330^\circ + 35^\circ$ ...	March 29–April 24 ...	4 ...	Slowish; radiant well-defined.
$216 - 26$ ...	April 11–24 ...	5 ...	Rather swift, bright, long. Exhibited great variety of colour.
$236\frac{1}{2} + 51\frac{1}{2}$ ...	April 19 ...	4 ...	Short; rather swift. Radiant sharply defined.
$256\frac{1}{2} + 37$ ...	April 19–22 ...	6 ...	Swift. Maximum April 22 (5 meteors).

The shower from 216°–26° is very interesting, inasmuch as nothing seems to have been seen of it previous to 1900, in which year it was very active at the Lyrid epoch from 218°–31°. It appears, therefore, to furnish quite a strong display at this period.

A recent writer has calculated that the maximum of the Lyrid shower would fall this year at April 19, 10h. 30m. My observations entirely negative this conclusion, for that night was marked by the complete absence of Lyrids, though the seeing conditions were extremely favourable. The time of maximum actually found was in accordance with that which had previously been inferred. Since in the last few years the maximum has taken place on the 20–21, it was to be expected that, after the omission of leap year in 1900, the epoch would be thrown one day later.

ALPHONSO KING.

Leicester, July 11.

THE WILD HORSE.[1]

IN the time of Pallas and Pennant, as in the days of Oppian and Pliny, it was commonly believed that true wild horses were to be met with, not only in Central Asia, but also in Europe and Africa. But ere the middle of the nineteenth century was reached, naturalists were beginning to question the existence of genuine wild horses; and somewhat later, the conclusion was arrived at that the horse had long "ceased to exist in a state of nature."[2]

This view had barely been accepted by zoologists when it was announced from St. Petersburg that a true wild horse had at last been discovered in Central Asia by the celebrated Russian traveller, Przewalsky.

An account of this horse was communicated by Poliakoff, in 1881, to the Imperial Russian Geographical Society.[3] The material at Poliakoff's disposal being limited, zoologists were not at once disposed to admit that Przewalsky's horse, as it came to be called, deserved to rank as a distinct species. Some believed the new horse had no more claim for a place amongst wild forms than the mustangs of the western prairies or the brumbies of the Australian bush; while others asserted it was merely a hybrid between the Kiang (*Equus hemionus*) and a Mongolian or other eastern pony.

Even after the brothers Grijimailo, in 1890,[4] added somewhat to Poliakoff's original description from material (four skins and a skeleton) brought from the Dzungaria desert, naturalists were still sceptical. The greatest English authority on the structure and classification of the Equidæ during the latter part of the nineteenth century was the late Sir William Flower. Writing in 1891, Flower says:—"Much interest, not yet thoroughly satisfied, has been excited among zoologists" by Poliakoff's announcement, but, he added, "Until more specimens are obtained, it is difficult to form a definite opinion as to the validity of the species, or to resist the suspicion that it may not be an accidental hybrid between the Kiang and the horse."[5]

Since Flower expressed this opinion, quite a number of specimens illustrating the form and structure of Przewalsky's horse at various ages have been added to the St. Petersburg Zoological Museum, and in 1902 Mr. Hagenbeck, of Hamburg (commissioned by His Grace the Duke of Bedford) imported from Mongolia between twenty and thirty living Przewalsky "colts." Though about half of these colts found their way to England, and though Dr. W. Salensky, director of the Zoological Museum of St. Petersburg, published last year an elaborate monograph[6] on Przewalsky's horse, English zoologists are not yet satisfied that we have in this member of the horse family a true and valid species.

So far as I can gather, it is generally believed in England that Przewalsky's horse is a hybrid—a cross between a pony and a Kiang. Beddard, however, admits it may be a distinct type. He says:—"This animal has been believed to be a mule between the wild ass and a feral horse; but if a distinct form—and probability seems to urge that view—it is interesting as breaking down the distinctions between horses and asses."[1]

It must be admitted that in its mane and tail Przewalsky's horse is strongly suggestive of a hybrid, but in the short mane and mule-like tail we may very well have a persistence of ancestral characters—in the wild asses and zebras the mane is always short, and they never have long persistent hairs at the proximal end of the tail.

Though a superficial examination may lead one to think with Flower that Przewalsky's horse is an accidental hybrid, a careful study of the soft parts and skeleton inevitably leads to quite a different conclusion. Though failing to understand why so many zoologists persisted in considering the horse of the Great Gobi Desert to be a mule, I decided to breed a number of Kiang-horse hybrids.[2]

Adderley.

FIG. 1.—Kiang pony Hybrid, *æt.* two days.

With the help of Lord Arthur Cecil, I succeeded early in 1902 in securing a male wild Asiatic ass and a couple of Mongolian pony mares—one a yellow-dun, the other a chestnut. "Jacob," the wild ass, was mated with the dun Mongol mare, with a brownish-yellow Exmoor pony, and with a bay Shetland-Welsh pony. The chestnut Mongol pony was put to a light grey Connemara stallion. Of the four mares referred to, three have already (June) foaled, viz. the Exmoor and the two Mongolian ponies. The Exmoor having foaled first, her hybrid may be first considered.

1 The Wild Horse (*Equus przewalskii*, Poliakoff). By Prof. J. C. Ewart, F.R.S. Read before the Royal Society of Edinburgh, June 15.

2 Bell's "British Quadrupeds."

3 A translation of Poliakoff's paper will be found in the *Annals and Magazine of Natural History*, 1881. See also Tegetmeier and Sutherland's "Horses, Asses and Zebras."

4 See *Proceedings* of the Roy. Geog. Soc., April, 1891.

5 Flower, "The Horse," pp. 78, 79.

6 "Wissenschaftliche Resultate der von N. M. Przewalski nach Central Asien." Zool. Theil: Band i., Mammalia; Abth. 2, Ungulata. (St. Petersburg, 1902.)

1 Beddard, "Mammalia," p. 240. (Macmillan, 1902.)

2 Sir William Flower, the late president of the London Zoological Society, having more than hinted in 1891 that Przewalsky's horse was a mule, one would have thought an effort would have been made forthwith to test this view in the Society's Garden.

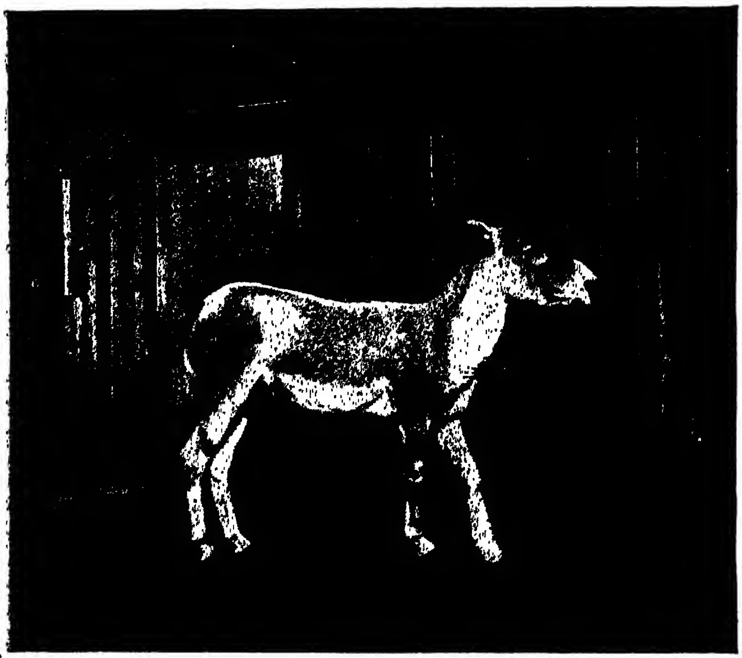
It may be mentioned that the Exmoor pony had, in 1900, and again in 1901, a zebra hybrid, the sire being the Burchell zebra "Matopo," used in my telegony experiments. In the case of her Kiang hybrid the period of gestation was 335 days (one day short of what is regarded as the normal time), but she carried her 1900 zebra hybrid 357 days, three weeks beyond the normal time. The Exmoor-zebra hybrids are as nearly as possible intermediate between a zebra and a pony; the Kiang-hybrid, on the other hand, might almost pass for a pure-bred wild ass.[1] In zebra hybrids the ground colour has invariably been darker than in the zebra parent; but the Kiang hybrid is decidedly lighter in colour than her wild sire, while in make she strongly suggests an Onager—the wild ass so often associated with the Runn of Cutch. Alike in make and colour, the Kiang hybrid differs from a young Przewalsky foal.[2]

I have never seen a new-born wild horse, but if one may judge from the conformation of the hocks, from the coarse legs, big joints, and large heads of the yearlings—from their close resemblance to dwarf cart-horse foals—it may be assumed they are neither characterised by unusual agility nor fleetness. The Kiang hybrid, on the other hand, looks as if built for speed, and almost from the moment of its birth it has, by its energy and vivacity, been a source of considerable anxiety to its by no means placid Exmoor dam. When four days old it walked more than twenty miles; on the fifth day, instead of resting, it was unusually active, as if anxious to make up for the forced idleness of the previous evening. In the hybrid the joints are small, and the legs are long and slender and covered with short close-lying hair. In the wild horse the joints are large, and the "bone" is round as in heavy horses.

As to its colour, it may be especially mentioned that the hybrid has more white around the eyes than the wild horse, but is of a darker tint along the back and sides and over the hind quarters. Too much importance, however, should not be attached to differences in colour, for, though the two hybrid foals which have already arrived closely agree in their coloration, subsequent foals may differ considerably, and it is well known that young wild horses from the western portions of the Great Altai Mountains differ in tint from those found further east.

Of more importance than the coat-colour is the nature of the hair. A Przewalsky foal has a woolly coat not unlike that of an Iceland foal. In the hybrid, the hair is short and fine, and only slightly wavy over the hind quarters. It thus differs but little from a thoroughbred or Arab foal.

The mane and tail of the hybrid are exactly what one would expect in a mule; the dorsal band, 75mm. wide over the croup in the sire, has in the hybrid a nearly uniform width of 12mm. from its origin at the withers until it loses itself half-way down the tail. The tail, which differs but little from that of a pony foal, is of a lighter brown colour than the short upright mane, while the dorsal band is of a reddish-brown hue. In the wild horse the dorsal band is sometimes very narrow (under 5mm.) and indistinct. In the Kiang sire there are pale but quite distinct stripes above and below the hocks, and small faint spots over the hind quarters—vestiges, apparently, of ancestral markings; but in the hybrid there are neither indications of stripes across the hocks or withers, nor spots on the quarters.[1]



E. Darwin-Wilmot.

Fig. 2.—Sire of Hybrid.

In having no indications of bars on the legs or faint stripes across the shoulders, the hybrid differs from Przewalsky colts; it also differs in having a longer flank feather, and in the facial whorl being well below the level of the eyes. As in the Kiang and wild horse, the under surface of the body and the inner aspect of the limbs are nearly white.

In the hybrid the front chestnuts (wrist callosities) are smooth and just above the level of the skin, but instead of being roughly pear-shaped as in the Kiang, they are somewhat shield-shaped, as in the Onager. In the wild horse the front chestnuts are elongated.

In the Exmoor dam the hind chestnuts (hock callosities) are 27mm. in length and 10mm. wide. In the sire there is a minute callosity inside the right hock. In the hybrid the hind chestnuts are completely absent. In the absence of hock callosities the hybrid differs from the wild horse, in which they are relatively longer than in Clydesdales, Shires, and other heavy breeds of horses. In the hybrid, as in the sire and dam, there are smooth, rounded fetlock callosities (ergots) on both fore and hind limbs.

In the wild horse the hoof is highly specialised, the "heels" being bent inwards (contracted) to take a vice-like grip of the frog. In the hybrid the hoof closely resembles that of the pony dam; it is shorter than in the Kiang, and less contracted at the "heels" than in the wild horse.

The Kiang hybrid further differs from a young wild

[1] The wild parent is generally prepotent over the tame—in Mendelian terms the Kiang proved dominant, the Exmoor pony recessive.

[2] For a skin of a very young Przewalsky foal I am indebted to Mr. Carl Hagenbeck, of Hamburg.

[1] The complete absence of stripes in the Kiang hybrid is all the more interesting, seeing that the dam's previous foals were zebra hybrids. Evidently the Kiang hybrid lends no support to the telegony doctrine.

horse in the lips and muzzle, the nostrils and ears, and in the form of the head.

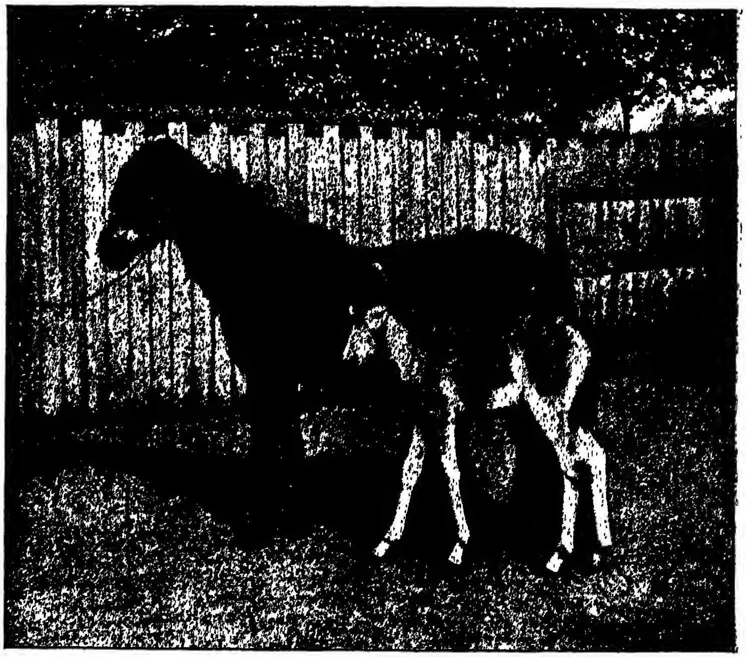
The wild horse has a coarse, heavy head, with the lower lip (as is often the case in large-headed horses and in Arabs with large hock callosities) projecting beyond the upper. The nostrils in their outline resemble those of the domestic horse, while the long pointed ears generally project obliquely outwards, as in many heavy horses and in the Melbourne strain of thoroughbreds. Further, in the wild horse the forehead is convex from above downwards, as well as from side to side—hence Przewalsky's horse is sometimes said to be ram-headed. In the hybrid the muzzle is fine as in Arabs, the lower lip is decidedly shorter than the prominent upper lip, the nostrils are narrow as in the Kiang, and even at birth the forehead was less rounded than is commonly the case in ordinary foals. The ears of the hybrid, though relatively shorter and narrower than in the Kiang, have, as in the Kiang, incurved dark-tinted tips, and they are usually carried erect or slightly inclined towards the middle line. In the wild horse the croup is nearly straight, and the tail is set on high up, as in many desert Arabs. In the hybrid the croup slopes as in the Kiang and in many ponies, with the result that the root of the tail is on a decidedly lower level than the highest part of the hind quarters. Further, in the young wild horses I have seen the heels (points of the hocks) almost touch each other, as in many Clydesdales, and the hocks are distinctly bent. In the hybrid the hocks are as straight as in well-bred foals, and the heels are kept well apart in walking.

Another difference of considerable importance is that while the wild horse neighs, the hybrid makes a peculiar barking sound, remotely suggestive of the rasping call of the Kiang.

The dun Mongol pony's hybrid arrived five weeks before its time, and, though perfect in every way, was short-lived. Only in one respect did this hybrid differ from the one already described. In the Exmoor hybrid the hock callosities are entirely absent; in the Mongol hybrid the right hock callosity is completely wanting, but the left one is represented by a small, slightly hardened patch of skin sparsely covered with short white hair.[1] In zebra hybrids out of cross-bred mares the hock callosities are usually fairly large, while in hybrids out of well-bred ("Celtic") pony mares the hock callosities are invariably absent. The Exmoor pony, though not so pure as the Hebridean and other ponies without callosities, has undoubtedly a strong dash of true pony blood; the Mongol pony is as certainly saturated with what, for want of a better term, may be called cart-horse blood. As I expected, there were no hock callosities present in the Exmoor hybrid. In the Mongol hybrid there was less evidence of hock callosities than I expected.

From what has been said it follows that a Kiang-horse hybrid differs from Przewalsky's horse (1) in having at the most the merest vestiges of hock callosities; (2) in not neighing like a horse; (3) in having finer limbs and joints and less specialised hoofs; (4) in the form of the head, in the lips, muzzle, and ears; (5) in the dorsal band; and (6) in the absence, even at birth, of any suggestion of shoulder-stripes and of bars on the legs.

While most of the zoologists who hesitated to regard Przewalsky's horse as representing a distinct and primitive type favoured the view that it was a mule, some asserted that it in no way essentially differed from an ordinary horse. The colts brought from Central Asia, they said, were the offspring of escaped Mongol ponies. Others affirmed that they failed to discover any difference between the young wild horses in the London Zoological Gardens and Iceland ponies of a like age. To test the first of these assertions, I, as already mentioned, mated the chestnut Mongol pony with a young Connemara stallion; to test the second, I purchased last autumn a recently-imported yellow-dun Iceland mare in foal to an Iceland stallion. As I anticipated, the chestnut Mongol mare produced



E. Darwin-Wilmot.

FIG. 3.—Exmoor pony and her Hybrid foal, *æt.* 9 days.

a foal the image of herself. This foal, it is hardly necessary to say, decidedly differs from the Przewalsky colts recently imported from Central Asia by Mr. Hagenbeck, and it as decidedly differs from the Kiang hybrids described above.

The Iceland foal, notwithstanding the upright mane and the woolly coat, for a time of a nearly uniform white colour, could never be mistaken for a wild horse, and the older it gets the differences will become accentuated.

If Przewalsky's horse is neither a Kiang-pony mule nor a feral Mongolian pony, and if, moreover, it is fertile (and its fertility can hardly be questioned), I fail to see how we can escape from the conclusion that it is as deserving as, say, the Kiang to be regarded as a distinct species. Granting Przewalsky's horse is a true wild horse, the question arises: In what way, if any, is it related to our domestic horses? It is still too soon to answer this question; but I venture to think that should we, by and by, arrive at the con-

[1] The presence of hair in the imperfectly-formed hock callosity of the Mongol hybrid, together with the presence of hair rudiments in the developing hock callosity of the common horse, certainly lends very little support to the view held by some zoologists that the chestnuts of the horse are vestiges of glands.

clusion that our domestic horses have had a multiple origin—have sprung from at least two perfectly distinct sources—we shall probably subsequently come to the further conclusion that our big-headed, big-jointed horses, with well-marked chestnuts on the hind legs, are more intimately related to the wild horse than the small-headed, slender-limbed varieties without chestnuts on the hind legs; that, in fact, the heavy horses, whether found in Europe, Asia, or Africa, and Przewalsky's horse have sprung from the same ancestors.

HIGHER TECHNICAL EDUCATION IN GREAT BRITAIN AND GERMANY.[1]

H.M. Consul at Stuttgart, Dr. Frederick Rose, has rendered excellent service to the cause of technical education by the admirable reports which he has from time to time sent to the Foreign Office; but no previous report of his presents such a clear view of the extent of the provisions for technical education in Germany and of the nature of the services which the technical high schools render to the nation as does the one recently published by the Foreign Office.

Dr. Rose is not a mere blind enthusiast for education, unable to see the other factors which have made for the commercial progress of Germany. On the contrary, he gives due weight to the system of protection, the orderly habits inculcated by the universal system of military service, and other matters which contribute in this direction; but after doing this he is still compelled to recognise the great part played by the German technical high schools in the industrial development of the nation.

The object of this article is to compare the condition of technical education in the United Kingdom with the condition in the country with which Dr. Rose deals; unfortunately, the comparison is one calculated to give Englishmen little satisfaction.

In this country we have a fairly large number of technical institutions with many thousands of students; indeed, in numbers only, it is probable that we should compare not unfavourably with our German cousins. But when we look more closely into the statistics we find that in most of these institutions the majority of the students are attending evening classes only, and that of this majority a very large number are engaged in work of an exceedingly elementary character. If one considers the day students and restricts oneself to those who are above the very low minimum age of fifteen, it is found that, counting not merely the technical institutions, but also the universities and university colleges, the total number of day students for the United Kingdom amounted in 1901 to less than 4000. The corresponding total for the German Empire was, in 1902, nearly 15,000.

These figures, as they stand, are sufficient to show how very backward we are in this country in the matter of higher technical education; but, when we bring into the comparison the ages and previous education of the students of the two countries, we see that the above figures by no means adequately show how far we are behind the foreigner in the matter of training. For it must be remembered that, with very few exceptions, all students in German technical high schools commence their studies when they are not less than eighteen years of age, and after passing with credit a nine years' course of instruction in secondary schools. We may estimate that of the 4000 students over fifteen in institutions in the United Kingdom providing technical education in the daytime, at least 1400—probably considerably more—were under eighteen; this reduces us to 2600 students to compare with the 15,000 of Germany.

Nor is this all; for, while the majority of the German students pursue their course of study for at least three years, and in many cases for four, in this country only a very small proportion proceed beyond two years; thus it was found that in 1901 there were about 400 third or fourth year students taking complete day courses in engineering in the *whole United Kingdom*; at the same time there were in the Berlin Technical High School *alone* more third and fourth year students of engineering than in all the universities and colleges of the United Kingdom put together; moreover, none of these German students were under twenty, while our figures could only be obtained by counting every student of this standing over seventeen.

To what must we attribute our great inferiority in this respect? In the first place to the condition of secondary education in this country; secondly, to the fact that German and American manufacturers believe in technical education, while many of their competitors in this country are still blind to its advantages; and thirdly to the fact that, while our Government contributes with liberality to elementary education, it is exceedingly parsimonious in its dealings with higher education.

First, then, let us look at the question of secondary education. Dr. Rose's report gives an adequate idea of the splendid character of the preliminary training which young Germans receive before they enter the technical high schools or other higher institutions in Germany. The secondary schools to which he refers are accessible to children of intelligence all over the Empire; they are carefully graded so as to overlap one another as little as possible, and every inducement is given to parents to allow their children to pursue a complete course of study. The leaving certificates of these schools confer upon children the right of entry to the universities and technical high schools, while they also form a starting point for those who wish to enter the more important branches of the State service, and confer the right to escape part of the compulsory military training. We may hope that in this country the new education authorities will improve our secondary education. Is it too much to expect that the Government may issue a leaving certificate conferring similar privileges to the German one, and taking the place of the medley of university local, Board of Education, Army, Navy, and Civil Service examinations, and many others, which now hang like mill-stones round the necks of the teachers in secondary schools.

The problem how to make British manufacturers believe in technical education is one which is slowly solving itself, and within the recollection of the present writer an improvement in this direction has taken place. That the improvement has not been more rapid is partly due to the fact that in this country the imperfectly trained student has been over-confident in his own powers to an extent only explicable by considering the shortness and imperfection of his training. The half-educated, college-trained youth has thus often become a laughing-stock in the shops; he has given his opinions freely, and they have not infrequently been wrong.

In some of the best technical institutions we are altering all this; our students are made to understand that the preliminary training they receive is only a preliminary training, enabling them to acquire more complete knowledge later, but not entitling them to

[1] "Report on the German Technical High Schools." By Dr F. Rose, H.M. Consul, Stuttgart. (No. 591, Miscellaneous Series of Diplomatic and Consular Reports.)

Since this article was written, Lord Rosebery's letter has appeared, foreshadowing the establishment of a technical high school approximately on the Berlin scale in London. But the writer lets the article stand; for one such institution will scarcely suffice for the ultimate needs of the metropolis alone. It may be hoped, however, that similar developments will occur in our other great centres of population.

become critics. Our manufacturers, on the other hand, are learning to value young men who have had a sound training, and it is becoming less and less difficult each year to find suitable places for students of this kind, even though many of the students are prolonging their training longer than was the case some years ago, though still for a far shorter period in most cases than is the case with the German students.

In estimating the amount of assistance which the State gives to higher technical education in this country we are confronted with a serious difficulty, for the institutions in which such education is given are seldom concerned with this work only. The technical institutions spend much of their energy and financial resources on elementary work in evening classes, while in some cases they also include preparatory day departments, which are simply secondary schools of a modern type. In the university colleges which provide higher technical education, such work represents, as a rule, only a small fraction of their activity.

It is, however, quite certain that comparatively little of the grants made to technical institutions and university colleges can be considered as given specifically for higher technical education. Indeed, in so far as the former are concerned, the present policy of the Board of Education is to give high grants for secondary schools and elementary evening classes with numerous pupils, and but little aid to the day classes for adults, which form the most important part of the work of the best technical colleges.

The Scottish Education Department, on the contrary, has recently altered this for Scotland by selecting the institutions at Glasgow, Edinburgh, and Dundee, and putting them in a position of great liberty to develop their higher work, while promising to give aid, not so much for thousands of students doing elementary work as for the high quality of the advanced work done by a smaller number of persons. May we not hope that in England the authorities will soon adopt a similar policy?

As to Germany, Dr. Rose's report mentions the following facts. The Prussian State gave to the Berlin Technical High School alone, in 1871, an annual subvention of 8511*l.*; this grant has been gradually increased until, in 1899, it amounted to 33,675*l.*, while in the same year the total grant to the three Prussian technical high schools reached the sum of 65,350*l.*, being more than half the total revenues of these institutions. But besides these amounts, sums are independently voted by the Prussian Ministry of Finance towards meeting extraordinary expenses incurred for new buildings, machinery, apparatus, &c. If these sums be taken into consideration, we reach the grand total of 121,348*l.* a year. It must be remembered that these figures relate not to the whole of Germany, but simply to the kingdom of Prussia, with an industrial population many times less than that for which we have to provide leaders in the United Kingdom.

One of the tables in Dr. Rose's report shows in a remarkable way the great progress which has been made in the matter of higher education in Germany since the Franco-Prussian War. For the attendance of students at the German universities, technical, agricultural, and veterinary high schools, &c., has increased from 17,761 in 1870 to 46,520 in 1900; or to state the matter in another way, there were in such institutions in 1870 about nine students for every 10,000 male inhabitants of Germany, while in 1900 there were nearly seventeen students for every 10,000 male inhabitants. The rate of increase has been much more rapid in the technical high schools, though the universities also have made progress; the actual figures given by Dr. Rose are:—for the universities, 13,674 students in 1870, and 32,834 in 1900; for the technical high schools, 2928 in 1870, and 10,412 in 1900, irrespective in each instance of students in agricultural and mining high schools and other higher institutions. We see, then, that the attendance at the technical high schools has increased nearly fourfold during the thirty years, while in the same period the university students have become only about two and a half times as numerous.

An important point in Dr. Rose's report is that in Germany the technical high schools are independent of universities, although in some of the largest towns, such as Berlin and Münich, universities and technical high schools both flourish, existing side by side, and in some cases apparently overlapping, but not really so doing, since the object of the two institutions is not the same. The university students may be supposed to seek knowledge mainly for its own sake, while students in technical high schools propose to put their knowledge to commercial uses.

There is no doubt that this separation of technical work from the control of the university professors has been a good thing for both classes of institutions, which are now recognised as of equal standing in Germany by the action of the Emperor, as King of Prussia, followed shortly after by the King of Württemburg, whereby the technical high schools have the right of conferring the degree of doctor of engineering, thus putting them on a par with the universities in this respect. This action was taken notwithstanding the strong opposition of the Prussian universities, and the Emperor at the same time admitted the principals of the Prussian technical high schools to the Prussian House of Lords, and bestowed upon each of them the title of "His Magnificence."

Perhaps the most important lesson to be learnt from Dr. Rose's report is the need for the strengthening of the best technical institutions in England which provide for the training in day classes of our industrial leaders.

The report shows that in Germany higher technical education is concentrated in a limited number of institutions, and these the State makes thoroughly efficient. The result is the gathering into a single institution of such a large number of students that it is possible to provide for them buildings, equipment, and teaching staff on a scale far in advance of anything found here. Thus the teaching staff of the three Prussian technical high schools numbered in 1899 no less than 554, being one teacher for each nine students in attendance. This liberal staffing enables the German teachers to specialise, greatly to the advantage of the country, the students, and the teachers themselves. In Germany a man is not—as is the rule here—expected to deal with the whole range of such enormously wide subjects as, *e.g.* electrical engineering. One teacher has a thorough knowledge of central station equipment, another of telephony, a third of electro-motors, a fourth of electro-plating, and so on.

It is evident, then, that, if we wish our higher technical training to be as good as that of the Germans, we must concentrate our students. But this has been difficult, because our technical education has been so largely in the hands of local authorities; these bodies are naturally anxious to give the highest form of training for many industries within their own limits, but they are not, as a rule, willing to expend the very large sums needed to make this possible; nor would such an expenditure be wise. We have, therefore, in the United Kingdom a comparatively large number of institutions each attempting—for the most part inefficiently—to do the highest work in many branches of technology.

If imperial patriotism would but outweigh local partiality, the sums already available might go further

than they do at present to provide better training for our industrial leaders. In London one may hope that this may be effected by inducing certain institutions to specialise in given directions. To take a case in point, the buildings, equipment, and numerical size of the staff of the Central Technical College might be equal to dealing satisfactorily with one branch of engineering or of applied chemistry. At present the college undertakes nearly all branches, and does it remarkably well, considering the difficulties under which it labours. If all the teaching staff for higher work in London were amalgamated, it would still be inferior in quantity—and, probably, in quality for *specialised* work—to that at Berlin; but it would not be, as is at present the case in the more or less isolated institutions, far too small for the work it is trying to do.

In the provinces the problem is more difficult, but not insoluble, if we are all more anxious for the good of the nation than for the glory of our own town or institution. Elementary technical education is needed in all the towns, but technical colleges are wanted in a few great cities only; and even in these populous centres every important branch of technology cannot be taught with efficiency, because, for a long time, there will be too few students to warrant adequate expenditure. Why should Sheffield and Leeds, *e.g.* both attempt the highest work in metallurgy and mining? Might not Sheffield send, say, its mining teachers and students to Leeds for higher work, and Leeds return the compliment by helping to develop the highest possible training in, say, metallurgy at Sheffield?

The case mentioned is only one instance of a principle which the Government ought to seek to establish generally, and to induce local authorities to adopt by offers of suitable grants in aid of what is really a pressing national need, viz. the development and improvement of our higher technical training. Each of the great cities might be made a centre for the highest training for one or more of our national industries, and the neighbouring cities should be willing to act as feeders to it in respect of this higher work.

Unless some such policy be adopted, there seems but little chance that we shall ever be able to offer a training equal to that available in Germany. For it would require enormous and wholly unnecessary expenditure to develop into a first-class technical high school dealing with many branches of technology, every technical institution and university college which is at present attempting to give some form of higher technical training.

Above all, let us note that both in Germany and America the flourishing technical colleges are not, as a rule, under the control of the universities, but exist side by side with them as co-equal organisations with different aims. To subordinate higher technical education to ordinary academic control would be to make a mistake which our German and American cousins have carefully avoided. Technical institutions might, however, very well become constituent parts of a university, provided, as has, *e.g.* been arranged at Sheffield, that they retain a sufficient measure of self-government. The scheme of Prof. Riedler, which Dr. Rose quotes with approval, would be a very good basis upon which to make a division between the work of our technical institutions and university colleges which exist in the same area, and, to some extent, overlap one another.

The university college might embrace, as Riedler proposes for the universities of Germany, the faculties of law, theology, medicine, philosophy, languages, history, State science, art, mathematics, and natural science; while the technical institutions would on his plan embrace the faculties of engineering, mining, forestry, agriculture, military science, and applied chemistry.

Finally, it may be well to quote the words in which Dr. Rose summarises the results of his extensive inquiries:—"The technical high schools cannot boast of the proud traditions of the old universities, nor are their buildings and institutions regarded with those feelings of gratitude and reverence which a long and honourable career in the service of humanity naturally inspires; but in default of this they can point to an almost perfect organisation and equipment for modern requirements, and to a development within the last forty years almost unparalleled in the annals of educational history." May a similar statement be possible ere long in regard to our own higher technical institutions!

J. WERTHEIMER.

THE TENTH "EROS" CIRCULAR.[1]

"AS an example of needless duplication, fifty observatories agreed to observe the planet Eros during its opposition in 1900, but so far as known, only two or three have made the reductions needed to render their observations of any value." So wrote Prof. E. C. Pickering in April, in his "Plan for the Endowment of Astronomical Research"; and he is not alone in asking, directly or indirectly, when we may expect to have the result of all the work done at the opposition of 1900-1. The tenth Eros circular, dated June 1, appears at the right moment as a provisional reply. It gives the results of equatorial observations at twelve observatories, all compared with the ephemeris; and two splendid series of photographic observations made at Bordeaux and Paris, completely reduced so as to show not only the comparison of the planet's place with the ephemeris, but a series of places for individual stars such as has never been given before. If these two observatories had done nothing else in the two years elapsed since the plates were taken, they might be congratulated on a fine piece of work. Other results will doubtless follow now that these are in print to act as an incentive, and we need have no fears for the ultimate result.

It is, however, well to remember that the opposition of Eros came upon us at a time when our hands were already more than full with the ordinary work of the astrographic catalogue. It was an embarrassing choice whether to put aside the catalogue measures for a time, to finish them before undertaking the Eros work, or to try to do both simultaneously. The various observatories have selected one or other of these alternatives according to the stage which the catalogue work had reached. At Bordeaux and Paris a leisurely programme has been adopted for this work; the French Government has supplied ample means, but the vote has been spread over twenty-five years, and the work will be extended over the same period. It would have been ridiculous to defer the measurement of the Eros plates for any period of this kind, and we imagine the catalogue work has been put aside in order to measure the Eros plates. At Oxford, to take a different case, the catalogue work has been pushed forward rapidly so as to make the best use of the small sum available, and is on the point of completion. The Eros work can then be taken up without undue delay. At other observatories some compromise has doubtless been adopted between these extreme courses. So long as the work goes forward on the lines of least resistance there is no particular need to be anxious; and we welcome the appearance of the tenth circular as an outward and visible sign of the vitality of this research, which some were beginning to accuse of hibernation.

[1] Conférence Astrophotographique Internationale de Juillet, 1900. Circulaire No. 10. Pp. 318 Paris, 1903.)

The results already published tempt one sorely to estimate a provisional parallax. Indeed there is no need to resist the temptation if one keeps the results to oneself, and avoids multiplying provisional results in print which only make confusion. An excellent example of reticence has already been set. This much may be said from experience; if anyone indulges himself by studying the results in the tenth circular, he will find no reason to be dissatisfied with the accuracy of the work.

The circular concludes with 100 pages of tables for facilitating the photographic reductions. Such tables may be thrown into an endless variety of forms according to individual taste; and the differences between any two particular arrangements are not of much importance compared with the great advantage of having the tables published. The thanks of everyone who measures photographs are due to M. Lœwy for his tables in the tenth circular. H. H. TURNER.

NOTES.

WHEN it was announced, a few months ago, that Prof. von Neumayer, the distinguished meteorologist, was about to retire, on account of advanced age and ill-health, from his post of director of the German Naval Observatory at Hamburg, which was under his control for a considerable number of years, the rumour quickly gained currency in usually well-informed circles that his successor would not be a man of science but a naval officer. This rumour was discredited at the time by many people, but it proves to have been quite correct, for during the Kaiser's recent visit to Hamburg for the purpose of unveiling a statue to the Emperor William I., he summoned Captain Herz, of the Imperial Navy, to his presence, and informed him that he had been appointed to the vacant post with the rank of a Rear-Admiral. As the work of the observatory is necessarily so largely scientific, it may at first sight seem strange that a man, who, no matter how able he may be, is not a man of science, should be placed at its head. A similar arrangement, however, has been made in several other cases in recent years—as, for instance, in the construction department of the Navy, which until quite recently was under the supervision of scientific engineers, but is now in the hands of naval officers—and the explanation given is that a man of science in such a position is so overburdened with administrative work—for which, very possibly, he is not well fitted—that he has little or no time for scientific investigation. The naval authorities have, therefore, decided to utilise their investigators wholly for scientific purposes, and to place the work of organisation and administration into the hands of a naval officer who is a man of practical affairs.

A BUST of the late Sir William Flower, F.R.S., will be formally presented to the trustees of the British Museum by the "Flower Memorial Committee" on Saturday next, July 25. The ceremony will take place in the central hall of the Natural History Museum at 1.15 p.m. The bust will be unveiled by the Archbishop of Canterbury as the representative of the trustees of the museum.

PROF. W. J. MCGEE has been elected chairman, and Dr. J. H. McCormick secretary, of the committee of arrangements for the eighth International Geographical Congress to be held at Washington, D.C., in September of next year.

A FEW weeks ago we recorded the unveiling of a monument of Pasteur at Chartres. We learn from the *British Medical Journal* that on July 12 another monument was unveiled in the commune of Marnes-la-Coquette in the presence of many well-known men of science. It was in the district of Marnes-la-Coquette that Pasteur established his laboratory for the study of hydrophobia, and it was there that he died.

THE seventy-first annual meeting of the British Medical Association will be held at Swansea on July 28–31, under the presidency of Dr. T. D. Griffiths. After the delivery of the presidential address on July 28, the Stewart prize will be presented to Dr. F. W. Mott, F.R.S. Dr. F. T. Roberts will deliver an address in medicine, and Prof. A. W. Mayo Robson an address in surgery. The scientific work of the meeting will be conducted in eleven sections—medicine, surgery, obstetrics and gynæcology, State medicine, psychology, pathology, ophthalmology, diseases of children, laryngology, tropical diseases; Navy, Army, and ambulance.

THE Wilts Archæological Society held a meeting at Stonehenge on Friday last, and the Rev. E. H. Goddard gave an account of the raising of the leaning stone. Mr. Story Maskelyne, in thanking Sir Edmund Antrobus for his invitation to visit Stonehenge, said that, by raising the leaning stone, the biggest stone of its kind in England, one of the most important pieces of archæological work he had known had been accomplished. People might quarrel about barbed-wire fences and rights of way, but in his opinion the greatest public right in Stonehenge was the preservation of the monument, and that the present owner was doing to the best of his abilities.

THE long excursion of the Geologists' Association will be made from July 28 to August 4. The head-quarters will be at Berwick-on-Tweed, and in the course of the week the coast at Scremerston, Burnmouth, Eyemouth, and St. Abb's Head, and the country inland along the Whiteadder, the Eildon Hills and Melrose, and a portion of the Cheviot Hills will be visited. Silurian, Old Red Sandstone, Lower Carboniferous, various igneous rocks and glacial drifts will be examined under the direction of Mr. J. G. Goodchild, with Mr. R. S. Herries as excursion secretary.

THE death is announced of Mr. J. Peter Lesley, who from 1872 to 1878 was professor of geology and Dean of the Faculty of Science in the University of Pennsylvania, and was recognised in America as one of the most competent experts on coal and iron mining. From an obituary notice in *Science* (July 3) we learn that he was born in Philadelphia on September 17, 1819, and after graduating at the university in 1838, served on the first geological survey of the State, when he paid especial attention to the coal-deposits. On the abrupt termination of the survey in 1841 he passed through a course of theology, was licensed to preach in 1844, and was for some years pastor of a Congregational church at Milton, Mass. His views, however, underwent some changes, and returning to Philadelphia he again took up geological work, making elaborate surveys of several coal and iron fields in different States. For twenty-seven years he was secretary and librarian of the American Philosophical Society, part of the time holding the geological professorship in Pennsylvania, and in 1874 taking charge also of the second geological survey of the State. This last post he retained until 1893, when he retired to Milton. He died on June 1.

A SEVERE earthquake was felt throughout the island of St. Vincent on the morning of July 21.

WE have received the official *Protokoll* of the third meeting of the International "Commission" for Scientific Aëronautics, which was held in Berlin on May 20–25, 1902.

The meeting was attended not only by the members of the "commission," but also by a large number of delegates from various countries interested in aëronautical investigation. A report of the proceedings has already appeared in this Journal (vol. lxvii. p. 137, December 11, 1902). The opening address by Prof. Hergesell, president of the commission, gives a very lucid summary of the work already attempted in the investigation of the upper atmosphere by international cooperation, and of the general results achieved.

THE scientific balloon ascents on June 4 were made in broad northerly air-current, which covered nearly the whole of Europe. At Itteville (Paris) the balloon rose to 12,840 metres; the temperature at 10,490 metres was $-52^{\circ}.6$ C.; at starting $9^{\circ}.3$. At Zürich, an altitude of 15,750 metres was reached, minimum temperature, $-66^{\circ}.5$; at starting, $10^{\circ}.2$. At Berlin, a temperature of $-53^{\circ}.0$ was recorded at 11,500 metres; at starting, $10^{\circ}.2$. At Vienna, $-43^{\circ}.7$ was registered at 9500 metres; temperature at starting, $15^{\circ}.8$. At Pavlovsk, a kite rose to 4430 metres in the afternoon of June 3, temperature $-11^{\circ}.6$; on the ground, $23^{\circ}.0$. A balloon sent up from Bath rose to about 14,000 metres; it descended in the sea, and the record is not published.

DURING the past week thunderstorms have been prevalent in various parts of the United Kingdom. In the early morning of Saturday last, a sharp storm occurred in the neighbourhood of London, and rainfall exceeding one inch and a half was measured; another storm occurred in the afternoon of that day, and further heavy rainfall occurred in parts of the metropolis. On Sunday severe storms were experienced in the southern counties; in parts of those districts the roads were under water for some time, and much damage was done to crops. The barometer readings were, for several days, generally low and uniform over the whole country, and although the weather has seemed to be "close," the thermometer has been low for the season, the day readings being at times as much as 10° below the average.

DR. D. K. MORRIS, writing in the June number of the *University of Birmingham Engineering Journal*, gives an interesting description of the power transmission installation from St. Maurice to Lausanne. The installation is for the transmission of 5000 h.p. over a distance of 35 miles, and the chief interest in the scheme lies in the fact that high tension direct currents are used in place of alternating or three-phase currents. The choice of this system has enabled a much greater simplicity in switching gear to be attained without any loss in efficiency, which is stated to be as high as 94 per cent. The system is a constant current one, 150 amperes at all loads, the voltage varying with the power transmitted, and reaching a maximum of 22,300 volts. The generators at the St. Maurice power station are designed to generate 150 amperes at about 2000 volts, and are connected in series, more machines being put in circuit as the load rises. The high voltage involves very special precautions in the insulation not only of the machine windings, but also of the machines themselves. The windings are very carefully insulated in the ordinary way, and, in addition, all the active parts of the armature are separated from the support by micanite insulation; the machines are insulated from earth by heavy porcelain insulators in which the lower ends of the foundation bolts rest. The journal contains several other interesting contributions from the pens of students and others, and affords ample evidence of the flourishing condition of the engineering school at the university.

AN interesting and rare case of infection of the mouth and subcutaneous tissues by a parasitic nematode worm is recorded by Mr. Whittles (*Lancet*, May 23). The patient had never been out of England, and the source of infection was surmised to be a pet Pomeranian dog. In a tropical disease affecting the skin, known as "craw-craw," a nematode has been described by Mr. O'Neil (possibly *Filaria perstans*), and the *bilharzia* may cause papillomatous growths.

AN interesting and exhaustive report has been issued by the Worcestershire County Council upon the bacterial treatment of sewage by different methods, the analytical details being supplied by the county analyst, Mr. Cecil Duncan. The conclusion arrived at is that the best method for the treatment of domestic sewage is a closed septic tank with bacterial beds filled with coke, which was found to be better than coal, brick or stone, two bacterial beds being provided to be used alternately to avoid ponding. As regards fish-tests of effluents, it is remarked that the Salmonidæ require a larger quantity of oxygen than the Cyprinidæ. Mr. Duncan gives details of the methods of analysis used, and suggests several modifications of those usually employed. For preparing ammonia-free water for analytical processes he has found that boiling ordinary distilled water with bromine-water (1200c.c. and three drops) for a few minutes is a rapid and trustworthy expedient.

THE first edition of the Kew hand-list of the Coniferæ has been exhausted for some time, and the authorities have published a new edition, which brings up to date the catalogue of species now in cultivation in the gardens. The revision has been undertaken by Dr. Masters, who was also responsible for the first edition. There is a considerable increase in the number of varieties, but only a very slight addition of fresh species.

THE necessity for adopting a uniform system of nomenclature in botany is sufficiently obvious, but at present this desirable condition has not been attained. In the presidential address delivered before the Linnean Society of New South Wales, Mr. J. H. Maiden presents a good summary of the codes which have been drawn up with this object, and enumerates the chief difficulties which confront the systematist.

INSTANCES of the disappearance of uncommon or interesting plants in the neighbourhood of towns are unfortunately only too frequent, so that the gift of a small but particularly rich piece of land, presented by Mr. Willett to the Ashmolean Natural History Society of Oxfordshire, will appeal to all naturalists. The donor desired to perpetuate the name of his famous fellow-collegian, and suggested that the area should be known as the "Ruskin Plot." The unique character of the vegetation is due to the presence of oolite overlying the clay, and these provide the situation required by a number of orchids and sedges. Mr. G. C. Druce, who selected the spot, describes in a small pamphlet the interesting plants which are collected together.

WRITING in the Lombardy *Rendiconti*, Prof. A. Martinazzoli urges the desirability of initiating anthropological observations in the Italian elementary and other schools. In view of the fact that hitherto nothing had been done in that direction, it is to be regarded as an indication of progress that during the last year about six anthropometric laboratories were fitted up in Italy, but it will be a long time before, from this small beginning, results are reached comparable with those achieved in the United States.

The June number of *Biometrika* contains an interesting contribution to the discussion on Mendel's theory of inheritance by Prof. Weldon, in which further difficulties are put forward against the acceptance of the laws as interpreted and amended by Mr. Bateson. Mr. Darbishire gives, in the same number, his third record of the hybrids between waltzing mice and albinos, and Mr. Woods an account of his experiments in breeding rabbits as bearing upon the principles of the same theory. Among other interesting papers there will be found what appear to be preliminary attempts on the part of Mr. Geoffrey Smith to determine the mass relations of nucleus and cytoplasm in Actinosphærium, and of Dr. Warren to determine the relationship between the size of the cell and the size of the body in Daphnia. Further work in this very interesting but difficult field of research is much needed.

The North American representatives of the widely spread group of diminutive ants, known as Leptothorax, are revised by Mr. W. M. Wheeler in the *Proceedings* of the Philadelphia Academy (pp. 215 *et seq*). The small size and concealed position of the colonies of these ants (which in general contain only from 25 to 50 individuals) account to a great extent for our imperfect knowledge of the group.

In the June number of the *American Naturalist* Prof. B. Dean records partial and complete albinism, as well as polychromatism, in the hag-fishes. Since one species of the group is thus proved to possess a definite type of coloration, it is inferred that myxinoids, as a whole, can scarcely differ in this respect from true fishes, in which deep-sea forms are uniformly coloured, while shallow water types are variegated. Hence follows the further inference that the few existing forms are survivors of a once numerous tribe. Later on in the same issue Mr. C. J. Herrick discusses the sense-organs in the skin of fishes, and concludes that those species which possess terminal nerve-buds in the lateral line system of the outer skin detect and taste their food by means of these organs, while those which lack these structures in the skin have the sense of taste confined to the mouth.

An extremely suggestive and interesting paper by Dr. Lewkowitsch, dealing with problems in the fat industry, appears in the *Journal* of the Society of Chemical Industry, vol. xxii. No. 10. The author is of the opinion that a fresh wave of inventive activity is approaching in the various branches of the fat industry, and in his paper points out a series of problems which await solution at the present moment. Industries having for their object the refining of fats and oils, industries in which the glycerides undergo a chemical change but are not saponified, and those industries based on the saponification of fats and oils, are all dealt with in the paper.

The additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*), a Black Hornbill (*Sphagolobus atratus*) from West Africa, presented by Mr. T. Wright; two Arabian Gazelles (*Gazella arabica*) from Sheik Osman, Arabia, presented by Messrs. Wheatley and Glossop, R.N.; a Brazilian Tapir (*Tapirus americanus*) from South America, an Amazonian Manatee (*Manatus inunguis*) from the River Amazon, presented by Mr. Charles Booth; a Grey Squirrel (*Sciurus cinereus*) from North America, presented by the Lady Kintore; a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, a White Stork (*Ciconia alba*), European, deposited.

OUR ASTRONOMICAL COLUMN.

Bright Spots on Saturn.—Mr. W. F. Denning sends us the following approximate times of transit of two bright spots across the central meridian of Saturn, and the times of rising and southing of the planet during the next fortnight:—

1903	Spot "A" h. m.	Spot "B" h. m.	Saturn Rises h. m.	Saturn Souths h. m.
July 25	10 37	—	8 5	12 25
,, 26	—	14 18	8 1	12 21
,, 27	13 47	10 43	7 57	12 17
,, 28	10 12	—	7 53	12 13
,, 29	—	13 53	7 49	12 8
,, 30	13 22	10 18	7 45	12 4
,, 31	9 47	—	7 41	12 0
Aug. 1	—	13 28	7 36	11 56
,, 2	12 57	9 53	7 32	11 52
,, 3	9 22	—	7 28	11 47
,, 4	—	13 3	7 24	11 43
,, 5	12 32	9 28	7 20	11 39
,, 6	8 57	—	7 16	11 35
,, 7	—	12 38	7 12	11 31
,, 8	12 7	9 3	7 8	11 26
,, 10	—	12 13	7 0	11 18

The spots are separated by about three hours (=108°) of longitude, and are conspicuous objects when the planet is well defined.

Spectroscopic Observations of Nova Geminorum.—Photographs obtained in April by Prof. Perrine, using the Crossley reflector, show that, despite its reddish colour, the light from Nova Geminorum was rich in actinic rays. They do not show any trace of nebulosity around the star such as was obtained in the case of Nova Persei.

Spectrograms obtained with the small slitless spectroscope attached to the Crossley reflector, show that in the region photographed—$H\beta$ to λ 335—the spectrum somewhat resembles that obtained by Messrs. Wright and Campbell for Nova Persei in April, 1901, and consists of bright lines and bands superposed on a continuous spectrum; these lines are almost all accounted for by the hydrogen lines in that region. $H\epsilon$ and $H\zeta$, as well as the lines at λ 339 and λ 346, were the strongest lines in Nova Persei, but they are very weak in the recent Nova, whereas $H\beta$ and $H\delta$ are strong in the latter but very weak in the former spectrum; the chief nebular line, λ 501, which was conspicuous in the spectrum of Nova Persei, is not shown in these spectrograms of Nova Geminorum. These differences may be due to the different stages of development of the two stars.

A comparison of two spectrograms obtained on April 2 and 8 respectively, show a considerable alteration in the six days interval, particularly in the ultra-violet region, where the continuous spectrum became weaker and the bands at $\lambda\lambda$ 350, 374 and 384 consequently appeared stronger; λ 339 and λ 346 also appeared to have developed. $H\beta$ appeared weaker, and there was a faint condensation in the region of λ 501. This condensation appeared as a fairly well-marked line on a later photograph obtained on May 11. Visual observations showed a strong $H\alpha$ line and a condensation in the region about D_1 and D_2.

An ordinary photograph exposed on April 22, 23 and 24 for 6h. 29m. showed no trace of nebulosity around the Nova.

Reproductions of these region photographs and spectrograms, and a detailed account of the visual and photographic observations of Profs. Reese and Curtis accompany Prof. Aitken's article in Lick *Bulletin*, No. 37.

Measurement of the Intensity of Feeble Illuminations.—M. Touchet, of Paris, has devised an apparatus for measuring the intensities of such feeble illuminations as the Zodiacal Light and the Gegenschein. It is similar in appearance to a theodolite, but has a flame of constant illuminating power so arranged as to illuminate the field through a variable slit. This slit may be opened and closed, like the slit of an ordinary spectroscope, by a screw having a divided head, so that the intensity of the field illumination may be instantly made equal to that of the light it is desired to measure, and readings, which are reducible to a standard, thus obtained (*Bulletin de la Société Astronomique de France*, July).

THE GERMAN ROYAL NAVAL OBSERVATORY.—The twenty-fifth annual volume (1902) of the publications of this observatory, entitled "Aus dem Archiv der Deutschen Seewarte," contains descriptive papers on "The Regulation of Marine Compasses," "A New Free-horizon Astronomical Base Line," "The Definitive Determination of the Path of the Comet Swift (1899.I)," and "The Results of Sextant Tests made at the Observatory.

In addition to the introduction, Dr. Neumayer, the director, contributes an article on "A New Method of Forecasting the Meteorological Conditions of the North Atlantic Ocean," and a novel chart, indicating all the meteorological conditions obtaining in the North Atlantic area during March, 1902, accompanies the volume.

RECENT ADVANCES IN STEREOCHEMISTRY.[1]

IN the year 1803, just a century ago, John Dalton delivered a series of scientific lectures in the Royal Institution during the course of which he doubtless laid before his audience a theory which he had recently devised for the purpose of connecting together the vast number of isolated chemical facts known at the commencement of the nineteenth century. This theory, of which the centenary is being celebrated during the present month by the Manchester Literary and Philosophical Society, is known as the atomic theory, and was destined to form the foundation upon which the whole superstructure of modern chemistry has been built. For our present purpose Dalton's theory may be briefly stated in the form of the following two principles:—(1) Every element is made up of homogeneous atoms of which the mass is constant; (2) chemical compounds are formed by the union of atoms of the various elements in simple numerical proportions. In accordance with Dalton's hypothesis, chemical substances may be mentally pictured by imagining the atoms as small spheres which have the power of aggregating themselves together under suitable conditions to form complexes or "molecules"; thus, taking two similar spheres representing hydrogen atoms, in conjunction with a sphere of a different kind, representative of an atom of oxygen, a chemical representation can be given of the compound water, the molecule of which is composed of two atoms of hydrogen and one of oxygen. The original atomic theory offers no explanation of the observed fact that the atoms combine together in different proportions; this deficiency was remedied by the doctrine of valency enunciated by the late Sir Edward Frankland in 1852. Frankland supposed that the atoms of certain elements, such as hydrogen and chlorine, are unable to combine with more than one atom of any other element; these elements are termed monovalent. Other atoms, such as those of barium and zinc, can become directly attached to at most two other atoms; these are the divalent elements. Tri-, tetra-, penta-, hexa-, hepta- and octa-valent elements can be similarly distinguished, the valency of hydrogen being taken as unity, in order to measure and define the saturation-capacity or the atom-fixing power of the atoms of the other elements. It will be clear that for rough diagrammatic purposes we may provide the spheres representing the atoms with as many wooden pegs as the element itself exhibits units of valency; compound molecules can then be represented by fitting the atoms together by means of the pegs representing the number of valency-units possessed by the various constituent atoms. By so doing a great advance is made upon the atomic theory of Dalton's time, and a mental picture is obtained of the way in which the atoms are connected together within the molecule itself.

During the early part of the nineteenth century it became evident, principally from the work of Liebig and Wöhler in Germany, and of Faraday at the Royal Institution, that substances exist which possess totally different properties, but nevertheless have the same molecular composition; as this became slowly realised, the atomic theory was naturally called upon to furnish some adequate explanation. In view of the proven identity of molecular composition, the required explanation could only be sought for in differences in the atomic arrangement within the molecules of the several substances. That such differences can be successfully illustrated by the aid of the atomic models will be seen on considering some specific case. Ordinary ethyl alcohol and methyl ether differ greatly from each other—the first is a liquid, whilst the second is a gas at ordinary temperatures—but possess the same molecular composition, the molecule in each case consisting of two atoms of carbon, six of hydrogen and one of oxygen. These two substances have to be represented on the assumption that hydrogen is monovalent, carbon tetravalent, and oxygen divalent. By joining wooden spheres together in the order shown in the figures—in which the valencies of the component atoms are carefully respected—diagrammatic representations are obtained which illustrate to the chemist the differences existing between ethyl alcohol and methyl ether.

$$\begin{array}{ccccc} & H & H & \\ & | & | & \\ H- & C & - C & -OH \\ & | & | & \\ & H & H & \end{array} \qquad \begin{array}{ccccc} & H & & H & \\ & | & & | & \\ H- & C & -O- & C & -H \\ & | & & | & \\ & H & & H & \end{array}$$

Ethyl Alcohol. Methyl Ether.

Substances related to each other in this way are said to be isomeric; they have the same molecular composition, but different molecular constitutions. The step in advance which is involved in thus writing molecular constitutions or in constructing molecular models was taken by Kekulé in 1858.

Two great stages in the development of chemical theory have now been indicated. First, that contributed by Dalton, who regarded constancy of molecular composition as characteristic of a chemical substance; secondly, that further stage, attained as a result of the labours of Liebig, Wöhler, Faraday, Frankland and Kekulé, which involved the introduction of the idea that the chemical individuality of a substance is dependent upon its molecular constitution as well as upon its molecular composition. A third great development in the atomic theory had yet to take place.

Whilst the theoretical views which culminated in Kekulé's constitutional formulæ were at first found sufficient to explain numerous observed cases of isomerism, instances soon began to accumulate of substances which exist in so many isomeric forms that the Kekulé method of representation is incapable of accounting for them all. At an early date Pasteur showed clearly that substances exist which have the same molecular composition and the same molecular constitution, but which nevertheless differ in important respects. A crisis was ultimately reached when, in 1870, Wislicenus demonstrated the existence of three isomeric lactic acids, all having the molecular composition $C_3H_6O_3$ and the molecular constitution

$$\begin{array}{ccc} & OH & \\ & | & \\ CH_3- & C & -COOH \\ & | & \\ & H & \end{array}$$

and contended that he had amply proved the insufficiency of Kekulé's method of writing constitutional formulæ.

The step needed to rid the atomic theory of these apparent anomalies was indicated by van 't Hoff and Le Bel in 1874; they pointed out that the weakness of the Kekulé method lies in the tacit assumption that the molecule is spread out upon a plane surface, and that by throwing this assumption aside and taking a rational view of the way in which the molecule is extended in space, all difficulties immediately vanish. The considerations put forward by van 't Hoff and Le Bel form the basis of the subject now known as stereochemistry, the branch of science which deals with the manner in which the atoms are distributed within the molecule in three-dimensional space; they deal, in the first place, with the arrangement of the constituent atoms in the simple organic compound, methane, the molecule of which has the composition CH_4, or consists of one carbon atom and four hydrogen atoms. The Kekulé constitutional formula pictures the component atoms of the methane molecule as if joined together in one plane (Fig. 1), whilst according to the new view, the four hydrogen atoms are imagined situated at the four apices of a regular tetra-

[1] A discourse delivered at the Royal Institution on May 1 by Prof. William J. Pope, F.R.S.

hedron of which the carbon atom occupies the centre (Fig. 2). This is conveniently illustrated with the aid of a few cardboard models.

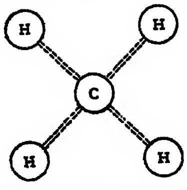


FIG. 1.

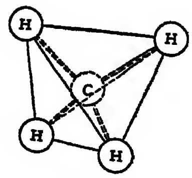
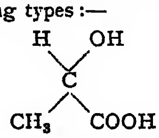
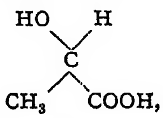


FIG. 2.

Consider now the result of replacing three of the four hydrogen atoms present in the methane molecule by three different groups of atoms, the three groups CH_3, OH, and CO_2H for example. One of the most striking results which has accrued from the chemical investigation of the past century has been the demonstration of the remarkable rigidity with which the atoms are held together in the molecule; it might therefore be anticipated that by actually making all the isomerides having the constitution indicated above, some means would be afforded of judging whether the van 't Hoff-Le Bel or the Kekulé view forms the closest approximation to truth. Kekulé's constitutional formulæ indicate the existence of two isomeric compounds of the following types:—



and



whilst on the van 't Hoff-Le Bel view, two isomerides of the nature illustrated by Figs. 3 and 4 are indicated; although in each case two isomerides would be obtainable, the examination of the two kinds of figure reveals very essential differences. The solid-figure isomerides differ only in that the one is the image in a mirror of the other—they are related in the same kind of way as a right and a left hand glove. The differences observable between two molecules thus related should consequently not be differences of an ordinary chemical nature, but differences involving merely a kind of chemical, physical and mechanical right- and left-handedness. The two Kekulé constitutional formulæ, on the other hand, would indicate—if they indicate anything—that the substances to which they refer differ in the more gross way in which ordinary chemical isomerides differ in chemical, physical and mechanical respect. That carbon atom which was present in the original methane molecule is, in these new compounds, now attached to four different atomic groups, and such a carbon atom is termed an "asymmetric" carbon atom. It is in the case of substances containing an asymmetric carbon atom that a lack of agreement is observed between the facts and the kind of isomerism indicated by the Kekulé

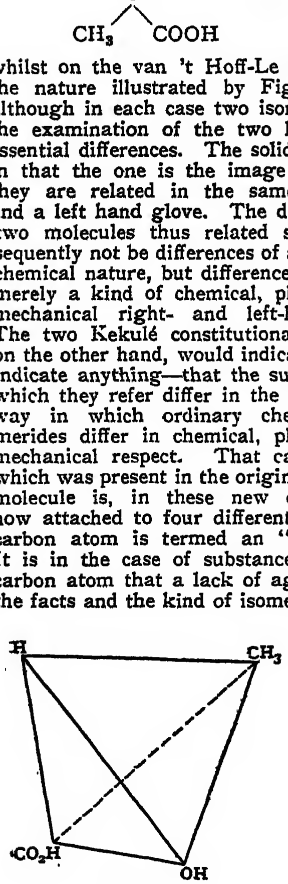


FIG. 3.

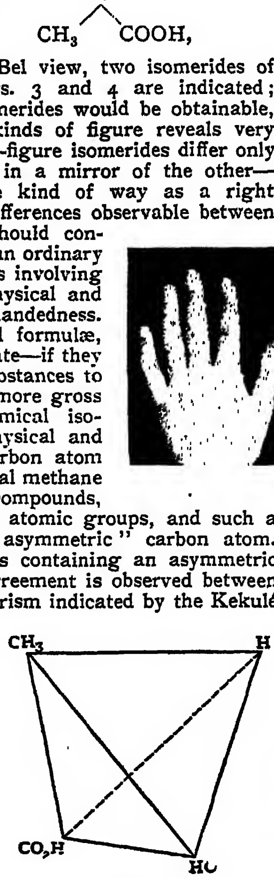
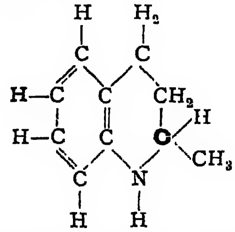


FIG. 4.

formulæ, and in these cases, also, the species of isomerism indicated by the solid models exhibited is found to correspond closely with the facts.

To illustrate this we may refer to a somewhat complicated substance, termed tetrahydroquinaldine, which has the following constitution:—



and the molecule of which contains an asymmetric carbon atom, that, namely, which is printed in heavy type. Three

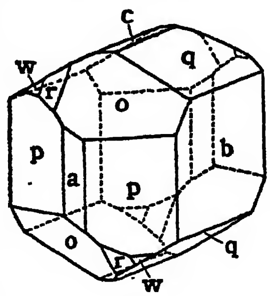


FIG. 5.

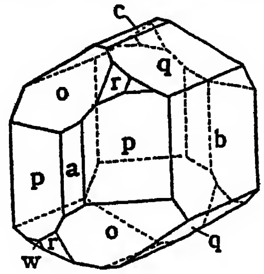


FIG. 6.

different isomeric forms of this substance exist, and are quite indistinguishable by any of the ordinary methods of chemical or physical identification; one of these is a loose kind of compound of the other two, and may therefore be disregarded for the moment. The remaining two have the same melting point, the same boiling point, and correspond exactly in all ordinary properties; they yield, however, series of derivatives which differ in the same sort of way that a right-hand and a left-hand glove differ. Here, for instance, is a diagram showing the shapes of the crystals

FIG. 7.

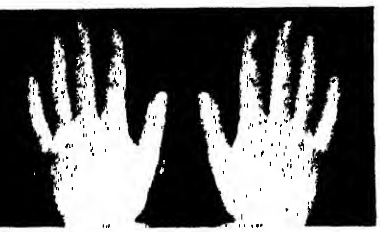


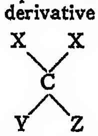
FIG. 8.

of the salts which these two substances form with hydrochloric acid (Figs. 5 and 6); the crystals obtained from the one base are the mirror-images of those prepared from the other. Any figure which possesses handedness of the kind exhibited by these two crystal figures is termed "enantiomorphous," and two figures which are related to each other as these figures are related are said to be "enantiomorphously related." A hand is thus enantiomorphous, and a right and a left hand are enantiomorphously related, the one being the mirror-image of the other. Here, for example, is a photograph showing a right hand and a left hand side by side (Fig. 7); the pair of hands is exactly reproduced in the next photograph (Fig. 8), which shows a right hand side by side with the photograph of its reflection in a mirror. Just the same enantiomorphous relationship as that existing between the right and the left hand, exists between the molecular pictures of the two lactic acids discovered by Wislicenus, and shown in Figs. 3 and 4.

Reference may now be made to the existence of other differences of an enantiomorphous character between substances which possess enantiomorphously related structures. Early in the last century the French physicists Arago and Biot showed that a number of substances have the power of deflecting the plane of polarisation of a plane-polarised

beam of light thrown through their solutions. Such substances are said to be optically active, and since the deflection of the plane of polarisation may be either towards the right or towards the left, the exhibition of optical activity constitutes an enantiomorphous property; optically active substances are conveniently classified as dextro- and lævorotatory. Van 't Hoff and Le Bel declared that the molecules of all naturally occurring substances which exhibit optical activity when in the fluid state contain asymmetric carbon atoms. All substances the molecules of which contain an asymmetric carbon atom must possess enantiomorphous molecular configurations—similar to those assigned to the two lactic acids—because they exhibit properties of an enantiomorphous character. A very beautiful experiment which the late Sir George Gabriel Stokes devised may be so modified as to serve for the demonstration of optical activity. Stokes's experiment consists in passing a plane polarised beam of light through a tall cylinder containing water which has been rendered very slightly turbid by the addition of a little alcoholic solution of resin; a spectrum is then seen spread out in the column of liquid, and spread out in a way which is not enantiomorphous, the water possessing no optical activity. The modification of Stokes's experiment consists in replacing the non-enantiomorphous water by some enantiomorphous liquid—conveniently by a 70 per cent. aqueous solution of the dextrorotatory cane-sugar, or by a 50 per cent. solution of the lævorotatory fruit-sugar; on making this change it is seen that instead of the spectrum lying in the cylinder vertically, and therefore non-enantiomorphously, it winds spirally or corkscrew-wise round and round the column of the enantiomorphous liquid. The two spirals or helices are clearly enantiomorphous, and the two liquids of opposite optical activity give rise in this experiment to oppositely wound spirals—to spirals which are related to each other like the right- and left-handed corkscrews shown in the lantern slide. The opposite sign of the rotatory power exhibited by the cane-sugar and fruit-sugar solutions is more clearly shown by turning the polarising prism in its mount, when the two spirals turn in opposite directions.

Although cases of optical activity are very frequently met with among chemical substances of animal or vegetable origin, it must be noted that no purely laboratory product or substance prepared without the use of enantiomorphous operations or materials is, in the ordinary way, optically active. The reason of this needs but little seeking, if the solid tetrahedron models are once more consulted. Starting with a non-enantiomorphous substance is equivalent to starting with a methane derivative of the constitution



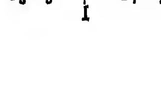
and replacing one of the two X groups by a fourth group Q so as to obtain a compound containing an asymmetric carbon atom. Obviously, unless some power of selection of an enantiomorphous nature is exercised in replacing X by Q, the doctrine of chance will ensure the one X group being replaced the same number of times as the other in an enormous number of tiny molecules. Thus there will result just the same amount of the right-handed optically active substance as of its left-handed isomeride. When an optically active substance is prepared in the laboratory, it is therefore obtained as a mixture of two enantiomorphously related isomerides; such a mixture is said to be compensated, because the right-handedness of the one component is just counterbalanced by the left-handedness of the isomeric constituent. These compensated substances are represented by the third lactic acid and by the third tetrahydroquinaldine previously referred to, but not further discussed.

Since one of the great problems with which chemistry is grappling involves the synthetic preparation of naturally occurring optically active substances, it is of the utmost importance that the chemist should be in possession of working methods for resolving these compensated mixtures into their optically active components. All the kinds of methods applicable to such resolutions necessarily involve the introduction of enantiomorphism—either of method or of material. Three types of methods were introduced by Pasteur, namely, (1) spontaneous resolution by crystallisation; (2) resolution by combination with optically active substances; and (3) resolution by the action of living organisms.

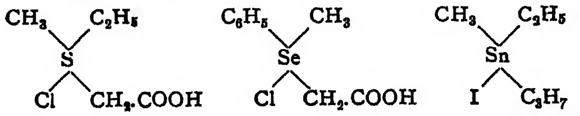
The first method depends upon the fact that on crystallising a compensated substance it sometimes deposits crystals of the dextro- and of the lævo-isomeride side by side, and of such size that they can be mechanically sorted. The enantiomorphous factor determining the separation in this kind of method is obviously the enantiomorphous intelligence which has the power of discriminating between right- and left-handedness. This sort of method is unfortunately but rarely applicable, owing to the fact that two enantiomorphously related substances usually crystallise together in the form of a loose chemical compound.

The second kind of Pasteur method is applicable to the resolution of compensated acids and bases, and depends upon the following considerations. On combining a compensated basic substance, viz. a mixture of *d*-B and *l*-B with an optically active acid—say with *d*-A—a mixture of two salts, namely *d*-B, *d*-A and *l*-B, *d*-A, will be obtained. These salts, however, are not enantiomorphously related, as will be realised on substituting for illustrative purposes a hand for the base and a glove for the acid; the combination *d*-B, *d*-A will then be represented by a right-hand in a right-handed glove, whilst the combination *l*-B, *d*-A will correspond to a left hand in a right-handed glove. The struggles of the left hand with the right-handed glove will not be a factor in determining the behaviour of the appropriately assorted right hand and right-handed glove. So, also, the properties of the substance *d*-B, *d*-A—its solubility, melting point, &c.—will be conditioned by an enantiomorphous relationship of quite a different order from that determining the corresponding properties of the salt *l*-B, *d*-A; the solubilities, being determined by different factors, will naturally also differ, and the two salts will therefore be separable by crystallisation. The first resolution of a compensated base was effected in 1885 by Ladenburg, and consisted in resolving the synthetic alkaloid coniine into its optically active components—one of which proved to be identical with the alkaloid contained in the juice of the hemlock—by crystallising it with dextrotartaric acid. Since this time the methods of resolving compensated bases have been materially improved by the application of optically active acids derived from camphor for use in place of the dextro-tartaric acid, and an experiment in illustration can now be shown on the lecture table.

On adding a solution of ammonium dextrobromocamphor-sulphonate to a solution of compensated tetrahydro-β-naphthylamine hydrochloride, a white crystalline precipitate of dextrotetrahydro-β-naphthylamine dextrobromocamphor-sulphonate—the salt *d*-B, *d*-A—is thrown down, whilst the lævotetrahydro-β-naphthylamine remains in solution as its hydrochloride. The resolution in this, and in many other cases, can be very rapidly effected, and by still further applying the optically active sulphonic acids derived from camphor a considerable extension of the original van 't Hoff-Le Bel theory has become possible. These workers traced all cases of optical activity to the presence of an asymmetric carbon atom, and deduced from their work the conclusion that the environment of the carbon atom in methane is a tetrahedral one. It is true that all the optically active substances which have yet been obtained from natural sources owe their optical activity to the presence of an asymmetric carbon atom, but it is important to note that by applying the second Pasteur method to the investigation of synthetic materials, substances owing their optical activity to the presence of asymmetric atoms of elements other than those of carbon can be prepared. Thus, ammonium iodide has the molecular composition NH_4I, and, like methane, contains in its molecule four hydrogen atoms which are replaceable by other atoms or groups of atoms; on replacing these hydrogen atoms by the four groups of atoms or radicles, methyl, allyl, benzyl and phenyl, a substance is obtained which is conveniently named methylallylbenzylphenyl-ammonium iodide, and has the following constitution:—



On replacing the iodine atom in this molecule by an optically active group of atoms, viz. by the dextrobromocamphorsulphonic residue, two salts are obtained, each of which contains an optically active basic part and an optically active acidic part; these are salts of the kinds *d*-B, *d*-A and *l*-B, *d*-A, and can be separated by crystallisation from a convenient solvent, and, after separation has been effected, each salt may be reconverted into the iodide. These regenerated iodides are found to be optically active in solution, and the conclusion is consequently drawn that optical activity is an attribute of the asymmetric pentavalent nitrogen atom as well as of the asymmetric tetravalent carbon atom. The optical activity of this substituted ammonium compound indicates that its molecule has an enantiomorphous configuration, and is extended in three-dimensional space; the exact nature of this configuration is not yet known, inasmuch as a space arrangement of five groups is concerned, but the environment of the nitrogen atom in ammonium salts is clearly not a simple tetrahedral one. Just as enantiomorphism has been proved to be an attribute of the asymmetric nitrogen atom, we have also demonstrated that asymmetric tetravalent atoms of sulphur, selenium and tin give rise to optical activity; optically active substances having the constitutions shown below have been prepared, and we are thus well on the way towards obtaining a complete stereochemical scheme embracing all the elements:—



It has been mentioned that optically active substances occur as such, rather than in the compensated form, in many animal and vegetable products, and also that when a substance containing an asymmetric carbon atom is prepared synthetically in the laboratory, it is of necessity obtained in the compensated form, or as a mixture in equal proportion of the dextro- and the lævo-isomerides. Taken together, these two facts have a very interesting bearing upon our speculations as to the origin of animal and vegetable life. Optically active substances have been isolated as products of the vital activity of all forms of animal or vegetable life which have been properly examined, but in spite of this they are never obtained directly as laboratory products; some enantiomorphous influence has always to be employed in their synthetic preparation, just as Pasteur applied enantiomorphism, either of method or of material, to the resolution of compensated substances. It was very strenuously argued by Prof. Japp, in his presidential address to the Chemical Section of the British Association in 1898, that no matter how successful we may be in reducing the problems relating to vital processes to mere questions of physics and chemistry, a residuum will always evade explanation by such means; this residuum will involve the discussion of the way in which the first enantiomorphous substance was resolved into its optically active components. This question involves the introduction of an enantiomorphous agency at some period during the evolutionary development of living matter. In attributing difficulty to the solution of this residuary problem, Dr. Japp implies that the enantiomorphous agency, the cooperation of which is essential, must be an intelligent agency. Let us ask ourselves whether the enantiomorphous agency premised is necessarily other than one acting fortuitously. The assumption of a fortuitously enantiomorphous agency is certainly all that need be made to explain the building up of many enantiomorphous systems. The dead universe itself, as we know it, is enantiomorphous, but this fact has never been regarded as a valid argument against the current hypothesis as to the cosmic origin of our planet. Some degree of obscurity is, however, introduced into the discussion of the primitive origin of the optically active substances now produced by animals and plants by the probability that ages of evolution have transformed the primeval optically active substance into multitudes of other and more complex products—have, in fact, accentuated the enantiomorphism to such an extent that physiological chemistry is now almost entirely the chemistry of enantiomorphous substances. If in any particular case, however, we can show that an optically active substance can be locally accumulated by the aid of some enantiomorphous agency acting purely fortuitously, it will be clear that the formation of the first optically active substance was not necessarily the work of an intelligent enantiomorphous agency. Such a species of separation of an optically active substance from a compensated one can be readily brought about in the laboratory. Pasteur showed that on crystallising the sodium ammonium salt of compensated tartaric acid (racemic acid) at ordinary temperature, large crystals separate, each of which consists of the salt of one or other of the *d*- and *l*-tartaric acids, the separation being brought about by the first of the Pasteur methods. If one of these crystals be selected casually, without the exercise of any selective intelligence, and used as a nucleus for inducing the crystallisation of further large quantities of the original solution, it will cause the separation of salt of its own kind, and ultimately a large quantity of salt of one of the optically active tartaric acids can be accumulated as a result of the introduction of an enantiomorphous agency such as might act fortuitously in a non-living universe. The probability of such a fortuitous agency arising would naturally be far greater in a living universe.

Again, suppose that at its origin life were carried on non-enantiomorphously, and that it involved the consumption and the production only of non-enantiomorphous substances and of compensated mixtures; it may well be foreseen that a stage in development might arise when each individual, in view of the increasing complexity of his vital processes, would have to decide to use only the one enantiomorphous component of his compensated food, and so evade an otherwise necessary duplication of his digestive apparatus. Acting unintelligently or fortuitously, one-half of the individuals would become dextro-beings, whilst the other half would become lævo-individuals; the succeeding generations would thus be of two enantiomorphously related configurations. It is, however, very difficult to believe that the natural selective operations which have been instrumental in conducting living organisms to their present stage of development would allow the perpetuation of this state of affairs for any considerable period; some fortuitous enantiomorphous occurrence would temporarily give the one configuration the advantage over the other, an advantage which would be quickly accentuated and would involve the permanent disappearance of the weaker configuration.

The kind of difficulties involved in the existence, side by side, of dextro- and lævo-individuals such as these may be shown by a simple illustration. There is no reason connected with human enantiomorphism why vehicular traffic should be forced to keep to one side of the road rather than to the other; as, however, the conditions of civilised life have gradually become more complex, economic reasons have arisen causing us to make an enantiomorphous selection, and in this country we arbitrarily force the traffic to keep to the left; other countries also make an arbitrary and sometimes a different selection. Even if, when legislation on this matter first became necessary, the population had been equally and obstinately divided upon the question of the rule of the road, we cannot doubt that by this time the question would have been satisfactorily and finally settled by the extermination of one or other of the enantiomorphously inclined parties without the cooperation of any intelligent enantiomorphous agency.

I mentioned that Pasteur gave a third method for the resolution of compensated substances, a method depending upon the selection exercised by living organisms upon the enantiomorphously related components of the mixture. He found, for instance, on allowing the mould *Penicillium glaucum* to grow in a solution containing compensated tartaric acid, that the mould used the *d*-tartaric acid as a food-stuff, and rejected the lævo-isomeride, which latter could ultimately be separated from the solution. The kind of method thus indicated has been applied with success in a great number of cases, and is, in the end, merely a special application of Pasteur's second method. During recent years a considerable change has taken place in our views upon the action of the lower organisms upon their food-stuffs. It was formerly supposed, for example, that the fermentation of sugar by an ordinary beer yeast is a part

of the vital process of the organism itself—that the sugar taken in as food by the organism is finally thrown out in the form of carbon dioxide and alcohol; it is now clear, however, that the formation of these two products is in no way a vital process. By triturating yeast with powdered quartz, so as to shatter the cell walls, and expressing the pulp thus produced, Buchner has succeeded in obtaining a solution which, when mixed with sugar solution, converts the sugar into carbon dioxide and alcohol. The fermentation is therefore not a vital phenomenon, but is a chemical action induced by some non-living substance contained in the expressed juice of the yeast cells. This substance—zymase—has been isolated in the solid state, and belongs to the class of substances known as unorganised ferments or enzymes. Although many enzymes are known, each active in inducing the occurrence of some particular chemical change or changes, nothing is as yet known as to their molecular constitutions; ages of evolution have given such complexity to these substances that a century or less of chemical investigation has contributed practically nothing towards elucidating their nature.

During the investigation of cases of animal and vegetable vital activity, great numbers of instances of the action of enzymes have been found, the function of the enzyme being to bring about the molecular degradation and, in certain cases, the molecular complication, of more or less complex materials used or produced in the organism. As an example of molecular degradation due primarily to enzymic action, the action of zymase on grape-sugar—*d*-glucose—may be quoted. In aqueous solution, one molecule of grape-sugar becomes directly converted into two molecules of alcohol and two molecules of carbon dioxide, in accordance with the equation

$$C_6H_{12}O_6 = 2C_2H_6O + 2CO_2,$$

by the enzyme zymase. The enzyme itself suffers no permanent change as a result of exercising the power of causing this chemical reaction to take place, so that a comparatively minute quantity of the enzyme, acting for a more or less prolonged period, is able to convert an unlimited quantity of grape-sugar into alcohol and carbon dioxide. The power which the enzyme possesses of inducing the occurrence of some chemical reaction which otherwise does not take place is not peculiar to enzymes; many substances, which are all classed together as the so-called catalytic agents, are known to exercise the same sort of influence in assisting a chemical reaction to occur. Thus the action of finely divided platinum in causing certain inflammable gases to ignite in air at the ordinary temperature is a catalytic action. The particular function exercised by enzymes in animal or vegetable life consists in bringing about chemical change, quietly and continuously, without necessitating the application of any violent chemical effects such as we are in the habit of using in the laboratory. Although they proceed so quietly, the chemical changes thus effected are, in certain cases, changes which we have not yet succeeded in carrying out without the assistance of an enzyme; in the conversion of sugar into alcohol and carbon dioxide, zymase is performing a reaction which has never yet been brought about by the use of the ordinary laboratory methods.

Without quoting more specific instances, it may be generally stated that most of the cases of enzymic action hitherto investigated are cases in which a large molecular complex is degraded or broken down into substances of lower molecular weight. But it is important to note that the organism is also the seat of processes which result in the building up of very complex molecules from simpler ones, such, for instance, as the formation of starch from carbon dioxide and water. A specific case in which enzymic action leads to the production of a complex substance from simpler ones has been recently worked out by Fischer and Armstrong, who show that the enzyme, lactase, converts the sugar galactose, $C_6H_{12}O_6$, into a new sugar, isolactose, $C_{12}H_{22}O_{11}$, of nearly twice the molecular weight of the former.

All the enzymes with which we are acquainted appear to be enantiomorphous bodies; they are, perhaps, substances to which no definite molecular composition can ever be assigned, inasmuch as they may be systems consisting of a number of different true chemical compounds, the system being one which becomes endowed with extraordinary chemical activity when placed in a suitable environment. The enantiomorphism of the enzyme has been repeatedly demonstrated during the course of Emil Fischer's remarkable synthetic work on the sugars. Fischer succeeded in preparing fruit-sugar or fructose by purely synthetical methods as a mixture of the dextro- and the lævo-isomerides; in order to isolate the previously unknown *l*-fructose, he applied the third Pasteur method in that he cultivated a yeast in the solution of the compensated fructose. The yeast enzyme—presumably zymase—has arrived at its present stage of development by passing through countless generations, all of which have been fed upon sugars of the dextro-configuration, these being the only ones occurring in Nature. In Fischer's experiment the enzyme therefore readily devoured the *d*-fructose, but refused to touch the *l*-fructose, which had never before been presented to it. The *l*-fructose was, of course, subsequently isolated from the solution. The need for compatibility between the enzyme and the material upon which it has to act is very clearly illustrated by considering the effect of yeast upon a number of optically active and isomeric sugars. In the table (Fig. 9) are given the constitutions of a number of sugars of the composition $C_6H_{12}O_6$, the configurations of the three or four asymmetric carbon atoms present in the molecule being indicated by writing the hydrogen atoms on the right or the left of the figure, as the case may be; the right or left hands indicate which asymmetric carbon atoms are of similar, and which of opposed, configurations.

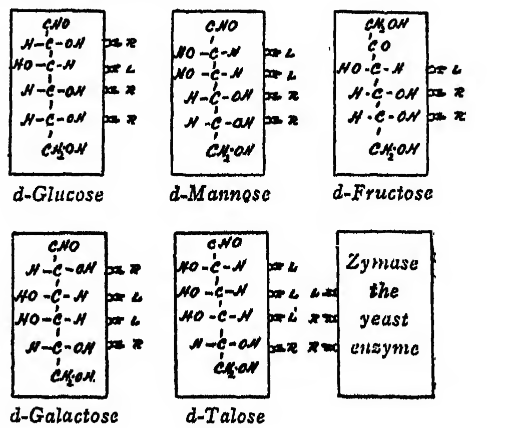


Fig. 9.

The beer yeast ferments *d*-glucose, *d*-mannose and *d*-fructose, each of which contains in the molecule a set of three asymmetric carbon atoms of similar configuration, with about equal readiness; *d*-galactose is, however, only fermented with difficulty—in the set of three asymmetric carbon atoms referred to, it contains one differing in configuration from the corresponding one in the three easily fermentable sugars. *d*-Talose, in which two of the three asymmetric carbon atoms differ in configuration from the corresponding carbon atoms in *d*-fructose, is quite unaffected by the yeast. It is just as if the enzyme were provided with three hands, in the order right, right, left, to enable it to grip the sugar molecule and commence tearing it to pieces; with these three hands it grips the corresponding hands—also of the configuration and order, right, right, left, of the first three sugars. The enzyme can, however, only grip the *d*-galactose molecule by two hands, and so obtains a less firm hold. Owing to the greater incompatibility between the zymase and the *d*-talose, the former obtains too feeble a hold on the latter to enable it to make a successful assault, and the sugar therefore remains unfermented.

The fact that the chemical reactions of animal and vegetable physiology consist, in the main, of the production or destruction of optically active substances through the agency of enantiomorphous enzymes is one of enormous importance. The complex substances concerned, such as starches, albumins and food-stuffs generally, occur in Nature in but

one of the enantiomorphously related configurations; all the albumins are lævo-rotatory, all the starches and sugars are derived from dextro-glucose. Since Fischer's work teaches us that none of the sugars derived from lævo-glucose are fermentable by yeast, it would seem to follow as a legitimate conclusion that, whilst *d*-glucose is a valuable food-stuff, we should be incapable of digesting its enantiomorphously related isomeride, *l*-glucose. Humanity is therefore composed of dextro-men and dextro-women. And just as we ourselves would probably starve if provided with nothing but food enantiomorphously related to that to which we are accustomed, so, if our enantiomorphously related isomerides, the lævo-men, were to come among us now, at a time when we have not yet succeeded in preparing synthetically the more important food-stuffs, we should be unable to provide them with the food necessary to keep them alive.

CHLORINE SMELTING, WITH ELECTROLYSIS.

A PAPER on chlorine smelting with electrolysis was read by Mr. Swinburne at the first meeting of the Faraday Society; as the process described in the paper is of considerable interest, and may one day be of great importance, we give a brief abstract of the paper below.

The process is one for the treatment of complex sulphide ores, such, for example, as the Broken Hill slimes, and is divided into three stages as follows:—(1) the treatment of the ores with hot chlorine, whereby the metals are all obtained as chlorides; (2) the treatment of the mixed chlorides by substitution until finally all the chlorine is combined with zinc; and (3) the electrolysis of the zinc chloride to extract the zinc and recover the chlorine. The first stage of the process is carried out by blowing hot chlorine into the crushed ore in a "transformer"; the essential feature is to avoid the formation of chloride of sulphur.

This involves a careful regulation of temperature and of the rate of feed of the ore; the temperature can be easily regulated by the rate of feed of the ore and chlorine as the reaction evolves a great deal of heat, and the transformer is entirely self-heating. Advantage can be taken of the composition of the ore, as some of the metals have a greater heat of reaction than others; if necessary, a mixture of ores of different compositions can be made so as to give a satisfactory working material. The sulphur is set free and condensed. At the end of a charge the ore feed is stopped, and the excess of sulphides converted to chlorides, after which the fused chlorides are drawn off and dissolved; the gangue having been separated by filtration, the second part of the process begins. This naturally depends on the composition of the ore; lead, silver, and gold are separated with the gangue, and after drying are fused first with lead, which extracts the silver and gold, and then with zinc, which gives lead and zinc chloride, the former practically pure. The filtrate is treated with spongy copper to separate lead and silver, and then with zinc to take out the copper. Iron, manganese, and zinc chlorides are left; the iron is chlorinated up to the ferric state, and precipitated as ferric hydrate by zinc oxide, and further chlorination in presence of the zinc oxide throws down the manganese as peroxide. There is thus left only zinc chloride in solution, and this is evaporated down and fused. To it is added the fused chloride from the lead substitution, and the whole is electrolysed in vats made of iron lined with fire-brick. The heating is internal; the current and the chloride soaking into and solidifying in the fire-brick gives really a vat with zinc chloride walls. Vats taking 3000 amperes have been in use, but these are small, and 10,000 ampere vats are to be tried; the pressure required is less than four volts. The result of the process is pure zinc and chlorine ready for chlorination of fresh ore.

It will be seen that the chief merits of the process are its comprehensiveness, its cyclical nature, and the fact that it turns out pure metals. Obviously it is suited, with only slight modifications, for the treatment of a great variety of ores. The chlorine simply goes round and round; apart from leakage, which, as Mr. Swinburne says, if it would show on the balance sheet would make the works uninhabitable, chlorine can only be lost as chloride of sulphur (a source of loss the inventors claim to have overcome), and as oxychlorides formed in the iron separation and in evaporation of the zinc chloride, neither of great importance if care be taken. The works therefore simply take in ore and electrical energy and turn out metals, sulphur, and gangue. Mr. Swinburne enters at some length into the question of cost, but space does not permit of our following him here; we have said enough to indicate the interesting character of the paper, to which those more specially interested may be referred for further details.

M. S.

THE ROYAL INSTITUTE OF PUBLIC HEALTH.

THE annual congress of the Royal Institute of Public Health was held at Liverpool, July 15–21, under the presidency of the Earl of Derby. The sections met in the various departments of the University College, and were thus closely associated and readily accessible. The proceedings were opened by an interesting address from the Earl of Derby, in which he directed attention to the considerable progress in sanitation that had been made by many ancient civilisations. The Harben medals for 1901 and 1902 were then presented to Sir Charles Cameron and Prof. W. R. Smith.

A combined conference of the preventive medicine and municipal hygiene sections discussed the subject of tuberculosis, and Dr. Nathan Raw read a paper upon "The Prevention of Consumption in Large Cities," in which he expressed the opinion that consumption is frequently conveyed to children by milk from tuberculous cows, though patients in the advanced stage are the greater source of danger to the community. He suggested as means for controlling the disease (1) the establishment of a central office where consumptives might seek advice; (2) the erection of a municipal sanatorium which, for Liverpool, should contain 100 beds, and be within the reach of any needy citizen; and (3) the foundation of a hospital for the poor for at least 100 incurable cases. Several other papers dealing with tuberculosis were also contributed; one, by Mr. McLauchlan Young, who summarised the experiments performed by Prof. Hamilton and himself upon the communicability of bovine tuberculosis to man, and expressed the opinion that there could be little doubt that human tubercle can be readily inoculated upon bovines; another, by Drs. Dean and Todd, upon the communicability of human tuberculosis to the pig, in which the six animals experimented upon were all infected with the human bacillus. Thus there is already an accumulation of evidence against the view expressed by Koch at the Tuberculosis Congress of 1901, that bovine tuberculosis is probably not communicable to man.

In the section of bacteriology and comparative pathology, the president, Prof. Boyce, F.R.S., in his opening address directed attention to the connection between abstract research and the good of the community, instancing the value of bacteriological research to practical medicine, to the farmer, to the water engineer, and to the oyster merchant. A paper by Dr. Savage upon "A Uniform Method of Procedure for the Bacterioscopic Examination of Water," evoked an interesting discussion. He considered the subject under four headings:—(1) the methods of collection and transmission of the samples; (2) the data which it is desirable to ascertain; (3) the processes and procedures of the examination; and (4) the significance to be attached to the results obtained. It was ultimately resolved to form a committee to consider whether it might not be possible to systematise the methods, &c., to be used for the bacteriological examination of water.

Another important discussion, upon "the nature and significance of the pseudo-diphtheria bacillus," was opened by Dr. Cobbett, who expressed the opinion that this organism has nothing whatever to do with the true diphtheria bacillus. Prof. Hewlett stated that he was not yet convinced that the two organisms had no connection, and directed attention to several points of similarity between the two. Several medical officers of health held that, whether the two organisms had any connection or no, the pseudo-bacillus sometimes produced a diphtheritic condition. It is im-

possible to summarise the number of important papers that were read upon the housing question, child-study, port sanitation, and other subjects. Dr. Hope, the local secretary, is to be congratulated upon the arrangements made, and it is hardly necessary to add that Liverpool extended a hearty welcome to the delegates and members of the congress. R. T. HEWLETT.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A REPORT on the scheme for the establishment, in London, of an institute for advanced technological instruction and research, recently put forward by Lord Rosebery, was presented to the London County Council on Tuesday. It will be remembered that the offer was made of land, buildings, and equipment required for such an institution to the value of 500,000*l.*, with the promise to secure other funds for both capital outlay and maintenance, provided that the council would express, in general terms, its willingness to contribute, when the buildings were equipped and ready to be opened, a sum of 20,000*l.* a year towards the maintenance of the educational work. In referring to these proposals in our issue of July 2 (p. 203), we pointed out the importance of coordinating the work of such an institute with that of the University of London, and expressed the opinion that the development of both was a national concern, and ought not to depend upon the contributions of the County Council. We are glad to see that the committee of the council appointed to consider the scheme regard substantial assistance from the State as an essential condition of support, and think the council should not lend any encouragement to the idea that the whole of the cost of maintenance could be provided from London sources. The following recommendations of the committee were adopted by the council at Tuesday's meeting:—(*a*) That the council expresses its high appreciation of the important proposal contained in Lord Rosebery's letter, and would cordially welcome the establishment of further provision in London for advanced technological teaching and research. (*b*) That the council, in response to the request contained in Lord Rosebery's letter, places on record its opinion that, when the land, buildings, and equipment for the proposed additional technological teaching and research are provided to a value of not less than 500,000*l.*, the council will be well advised to contribute, out of the moneys annually placed at its disposal under the Local Taxation (Customs and Excise) Act of 1890, a sum not exceeding 20,000*l.* per annum towards such part of the work as falls within the statutory definition of technical education, subject to the following conditions:—(1) That a scheme be prepared to the satisfaction of the council for the constitution of the governing body and the adequate representation of the council thereon; (2) that financial arrangements adequate to the whole maintenance of the proposed work are made to the satisfaction of the council; (3) that, in view of the national scope and utility of the proposed work, substantial contributions towards maintenance be made from funds of a national character; (4) that due provision be made in the scheme to prevent overlapping and secure coordination of the work already carried on by the university colleges, polytechnics, and other science and technological institutions, and the proper connection of the whole with the university; (5) that a sufficient number of scholarships, including free places, be placed at the disposal of the council; (6) that it be considered whether other counties and boroughs should not be invited to contribute towards the maintenance, receiving in return the right to send their picked scholars for instruction under the proposed scheme.

THE Board of Education have issued new regulations for the instruction and training of pupil teachers and students in training colleges. In a preface by Mr. Morant it is stated that the "regulations are intended to secure for the pupil teacher a more complete and continuous education, and to make the period of service in an elementary school a time of probation and training rather than of too early practice in teaching." Pupil teachers admitted on and after August 1, 1904, must not be under sixteen years of age, except in rural districts, where the limit will be fifteen. After August 1, 1905, pupil teachers will not be permitted to serve in a public elementary school more than half the time the school is open, and they will be required to receive half-time instruction in an approved pupil teacher centre throughout their engagement. The Board of Education desires to encourage plans for educating pupil teachers with other scholars, and urges local educational authorities to arrange, by means of an adequate scholarship system or otherwise, that all the best candidates for pupil teacherships, whether boys or girls, should receive a sound general education in a secondary school, with schoolfellows intended for other careers, before they commence service in any capacity in an elementary school. There is already in existence a number of well-equipped and well-staffed pupil teacher centres, the best of which have more than fulfilled the purpose for which they were originally recognised by the Board. The new regulations should assist in developing corporate school life in such centres, and also in improving other less satisfactory central classes; they mark a very decided step in advance, and show an exact appreciation of the shortcomings of the pupil teacher system as it has existed until now.

A SCHEME whereby pupils in schools in different parts of the Empire may be put in communication with one another, with the view of exchanging observations, specimens and ideas, has been drawn up by the League of the Empire, and promises to be of great educational value. The committee recommends that linked-schools and members should first exchange maps of their respective districts, and where possible, photographs or drawings of their houses, of the school house, grounds and surroundings. It is suggested that nature calendars should be kept, essays written on common trees or other plants, and notes made on the habits of birds or other animals, or on industrial processes or natural products in the neighbourhood of the schools—all with the view of exchanging them with schools in other parts. Personal observations are to be insisted upon, so that the descriptions will be twice blessed—those who make the observations by exercising the best of their faculties, and those who receive the results by gaining knowledge of natural conditions beyond their individual view. Specimens are also to be exchanged for school museums. Already there are nearly two thousand members in correspondence all over the Empire exchanging specimens and letters, and the number will doubtless be greatly increased. Particulars of the scheme may be obtained from Mrs. Ord Marshall, hon. secretary of the central committee, 11 Dartmouth Street, Victoria Street, London, S.W.

To prevent misunderstanding, Mr. C. McDermid, secretary of the Bessemer Memorial Fund, has issued a letter in which the relationship between the scheme for the Bessemer memorial and that put forward by Lord Rosebery is described. The persons responsible in each case have been in close consultation throughout, but the two schemes will continue for the present to be directed separately, though they will be controlled by joint trustees. For the purposes of the advanced metallurgical training and specialised research works which are to form the Bessemer memorial, it is proposed that London shall be regarded as the centre for the metallurgy of copper, silver, gold, &c., Sheffield as the centre for steel, and Birmingham as the centre for cast and wrought iron and alloys. It is intended that the post-graduate scholarships shall, in part, be international. It is hoped that the committee will be able to submit the complete scheme in October.

DR. W. SCHLICH, principal professor of forestry in the Royal Indian Engineering College, Coopers Hill, has been appointed honorary professor of forestry at the Royal Agricultural College, Cirencester. Mr. McClellan, jun., who was recently appointed professor of forestry and estates management at the college, has, during the past four months, been gaining experience of continental forestry, and with Dr. Schlich has made a six weeks' tour through specially interesting forest districts in Germany.

MR. H. W. RICHARDS has been appointed principal of the Brixton Technical Institute of the London Technical Education Board. The Board has made the following appointments in connection with the Paddington Technical

Institute:—Head of the chemical department, Dr. H. Reynolds; head of the physical department, Mr. J. H. Vincent.

THE following research fellowships and scholarships have been awarded by the executive committee of the Carnegie Trust for the universities of Scotland. *Research Fellowships.*—Chemical: Dr. C. E. Fawaitt, Dr. J. C. Irvine, Mr. W. Maitland. Biological: Dr. J. Cameron. Historical: Dr. D. Mackenzie. *Research Scholarships.*—Physical: Mr. J. H. MacLagan Wedderburn, Mr. H. W. Malcolm, Mr. J. R. Milne, Mr. T. B. Morley. Chemical: Mr. J. Knox, Mr. J. Johnston, Mr. F. J. Wilson. Biological: Mr. S. F. Ashby, Dr. R. T. Leiper, Mr. H. J. Watt.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 28.—"Researches on Tetanus." By Prof. Hans **Meyer** and Dr. F. **Ransom.**

The experiments were in the first place made with the object of finding an explanation for local tetanus. One of the earliest and most striking symptoms of tetanus in man is, as its popular name implies, stiffness of the masseter muscles (lockjaw); this is the case wherever the infected wound may be situated. In certain animals, however, as cats, dogs, and rabbits, when tetanus toxin is injected subcutaneously into a limb, the first symptom is a rigidity of the muscles of the injected member; this is known as local tetanus. Afterwards, if enough toxin has been given, the rigidity becomes general. An experimental explanation of this condition has hitherto been wanting.

The authors believe that their experiments prove conclusively that the course of events in experimental tetanus is as follows:—The toxin is taken up from the point of injection by the motor nerves (probably their naked endings). Passing along these it reaches first the corresponding motor centres in the spinal cord and excites there an over-irritability, so that the discharges which normally give rise to muscular tone become abnormally strong, and produce in the muscles of the injected limb the condition known as tetanic rigidity. The toxin also passes from the point of injection into the lymphatics and thence into the blood.[1] From the blood-lymph stream, if enough has been given, other motor nerve ends take up toxin, and general muscular rigidity ensues.

The authors show experimentally that the toxin only reaches the nervous centres by way of the motor nerves, and further, that the movement of the toxin in the nervous system does not take place in the lymphatics, but in the protoplasm of the nerves. Tetanus toxin never reaches the spinal centres along the sensory nerves, but, if it is injected into a posterior root, sensory disturbance is the result.

The greater part of what is known as the period of incubation, that is, the interval which elapses between the injection of toxin and the first symptom of intoxication, is the expression of the time occupied in the conveyance of the toxine from the periphery along the motor nerves to the susceptible centres.

Relying upon the results of their experiments, the authors are of opinion that the tetanus of warm-blooded animals consists of two processes, separated from each other both in time and space. Of these the one is primary, a motor intoxication, local muscular rigidity; the other, secondary, is a local sensory intoxication, a diffused reflex tetanus starting from the intoxicated neuron.

Repeated experiments showed that, when tetanus toxin was introduced direct into a motor nerve, antitoxin, though present in large quantities in the blood, was unable to prevent the outbreak of the disease, or even to hinder a fatal result. This was the case both when large doses of antitoxin were given before and after the toxin, as well as when an actively immunised animal was employed. The experimenters therefore conclude that injected antitoxin does not reach the substance of the nerve fibrils and centres, and that even with highly immunised animals the neurons remain free from antitoxin. As regards the serum treatment of tetanus, it is clear that in these circumstances any toxin which is already in the motor nerves, though not yet in spinal centres, will not be neutralised by antitoxin, whether injected under the skin or direct into the blood. An attack corresponding to the amount of toxin absorbed by the nerves will break out and run its course in spite of antitoxin. On the other hand, any toxin in the blood or lymph will be rendered harmless by an injection of antitoxin, and so a further intoxication will be prevented.

The authors have further made successful attempts to prevent the access of tetanus toxin along the motor nerve to the susceptible centres by injecting antitoxin into the nerve substance (ischiadicus), so, as it were, blocking the passage of the toxin.

Just before this paper was read, a case occurred at Marburg of a man who received an injury of the hand from the breaking of a flask of tetanus toxin. Antitoxin in large quantity was injected under the skin a quarter of an hour after the injury; nevertheless, after eight days, a local tetanus of the arm broke out. This was treated by injection of antitoxin into the nerve trunks of the affected limb, and the patient recovered. The occurrence of a local tetanus in spite of the large quantities of antitoxin, and the satisfactory result which followed, and perhaps was due to the injection of antitoxin into the motor nerves of the affected limb, show that the conveyance of the poison from periphery to centre takes place in men, as in animals, along the motor nerve, and affords, further, a valuable hint for the treatment of tetanus.

The full report of these experiments appears in *Archiv für experimentelle Pathologie und Pharmakologie*, Band xlix.

June 11.—"Observations on the Physiology of the Cerebral Cortex of the Anthropoid Apes." By Dr. A. S. F. **Grünbaum** and Prof. C. S. **Sherrington,** F.R.S.

June 18.—"Cyanogenesis in Plants. Part iii. Phaseolunatin; the Cyanogenetic Glucoside of *Phaseolus lunatus.*" By Wyndham R. **Dunstan,** M.A., F.R.S., Director of the Imperial Institute, South Kensington, and T. A. **Henry,** D.Sc. Lond.

The poisonous seeds produced by partial cultivation in Mauritius of the plant *Phaseolus lunatus* have been examined and found to contain a cyanogenetic glucoside of the formula $C_{10}H_{17}O_6N$, to which the name *Phaseolunatin* has been given. The glucoside crystallises in colourless needles, and when acted upon by the enzyme emulsin, which is also present in the seeds, or by warm dilute acids, it is hydrolysed into *dextrose, acetone,* and *hydrocyanic acid.*

$$C_{10}H_{17}O_6N+H_2O=C_6H_{12}O_6+CH_3.CO.CH_3+HCN.$$

Alkalis convert the glucoside into *phaseolunatinic acid* ($C_{10}H_{18}O_8$), and this, by the further action of hot dilute acids, is hydrolysed into *dextrose* and *a-hydroxyisobutyric acid.* Phaseolunatin is therefore the *dextrose ether of acetonecyanhydrin* $(CH_3)_2:C(CN).O.C_6H_{11}O_5$.

The seeds produced by *Phaseolus lunatus* vary in toxicity and in the colour of their seed-coats, depending upon the care bestowed on the cultivation of the plant. In Mauritius, where the plant is grown for use as a green manure, the seeds furnish, when moistened with water, from 0·041 to 0·088 per cent. of prussic acid, and possess dark brown or purple seed-coats; in India the seeds, which are imported into this country under the name of "Rangoon" or "Paigya" beans, and are used for the manufacture of cattle foods, are pink with purple spots, and yield only 0·004 per cent. of this acid, whilst the large, white Lima or duffin beans, produced by long-continued cultivation of the plant, yield no prussic acid, although they still contain the enzyme emulsin.

It is suggested that if hydrocyanic acid or its precursors —the cyanogenetic glucosides—in plants, may be regarded as formative materials utilised for the synthesis of proteids, then the absence of such glucosides from the cultivated seeds of *Phaseolus lunatus*, and from those of the cultivated almond, may be the result of more active metabolism induced by improved conditions of growth, so that no supplies of the glucoside are available for storage as reserve material in the seeds.

[1] Ransom, Hoppe Seyler's *Zeitschrift f physiol. Chemie,* Band xxix and xxxi.

Faraday Society, June 30.—Mr. J. Swinburne, vice-president, in the chair.—Mr. W. C. Dampier **Whetham**, F.R.S., gave an abstract of his paper on the present position of the theory of electrolysis. The fact that the products of electrolysis appear at the electrodes only led to the Grotthus chain hypothesis. Faraday's laws suggest opposite convective streams of anions and cations. Hittorf's observations on the unequal concentration of the solution lead to the conception either of complex ions, dragging along salt or solvent, or else unequal velocities of the ions the ratio of which can be measured. Kohlrausch's measurements of the resistance of electrolytes enable the absolute velocities to be measured. The fact that electric conduction in solutions obeys Ohm's law shows that the E.M.F. is merely directive, and that the ions have migratory freedom. The fact that ionic mobilities only vary slowly with dilution, while the conductivity of a dilute solution is proportional to the first power and not the cube of the concentration, shows that the ions must be free of the solute molecules—not necessarily of those of the solvent. The osmotic properties of electrolytes lead to the same conclusion. A short consideration of conduction in non-aqueous solution and in fused salts completes the paper.—Mr. **Swinburne** gave a short account of his paper on chlorine smelting, with electrolysis, an abstract of which we print elsewhere (p. 285).—A paper by Dr. R. A. **Lehfeldt**, on the total and free energy of the lead accumulator, was taken as read, and the discussion adjourned until the next meeting.—Dr. **Perkin** exhibited and explained several novel pieces of electrolytic apparatus devised by him for laboratory work.

PARIS.

Academy of Sciences, July 13.—M. Mascart in the chair —On the stability of a particular mode of flow of a sheet of water of infiltration, by M. J. **Boussinesq**.—On the torsional movements of the eye during the rotation of the head, by M. Yves **Delage**.—Remarks by M. Alfred **Picard** on the third volume of his "Rapport général sur l'Exposition universelle de 1900."—On the deformation of surfaces, by M. M. **Servant**.—On the measurement of coefficients of self-induction by means of the telephone, by M. R. **Dongier**. A special telephone invented by M. Mercadier was used in this work. It only reinforces sounds of a determined period, and remains insensible to the harmonics caused by capacity or by magnetic substances in the core of the bobbin. Measurements of self-induction of the order of 10^{-3} Henry were made with an accuracy of one-half per cent.—A combination of ferric sulphate with sulphuric acid, by M. A. **Recoura**. A ferrisulphuric acid has been isolated, possessing an analogous composition to the chromosulphuric acid previously described; unlike the latter, however, it is immediately decomposed by water.—On the action of carbon monoxide upon iron and its oxides, by M. Georges **Charpy**. Ferric oxide, heated in a current of carbon monoxide, is completely reduced to metallic iron, containing carbon, at all temperatures between 200° and 1200°, the velocity of reduction increasing with the temperature. Metallic iron takes up carbon at all temperatures between 560° and 1190° C., the metal remaining free from deposited carbon at temperatures above 750° C.—On the so-called colloidal silver, by M. **Hanriot**. The conclusion is drawn that the albuminoid material in collargol, the oxide of iron in the preparation of C. Lea, and the silica in the silicargol are not to be regarded as impurities, but as integral portions of the molecule, not only because it is impossible to separate them without destroying the colloidal silver, but also because these bodies have then lost their characteristic properties.—The action of hypophosphorous acid on diethylketone and on acetophenone, by M. C. **Marie**. Acids containing phosphorus have been obtained analogous in composition with acids derived from other ketones; the oxidation products are also similar.—On the chloride of phenylpropargylidene, $C_6H_5.C:C.CH.Cl_2$, by MM. Ernest **Charon** and Edgar **Dugoujon**. Phenylpropargylic aldehyde was treated with phosphorus pentachloride, and the chloride separated by fractional distillation. Its stability is greater than that of cinnamylidene chloride. The addition products with chlorine and bromine were isolated, and also proved to be very stable towards air and water.—The preparation of the secondary amides, by M. J. **Tarbouriech**. Two methods were used, the action of the acid on the corresponding nitrite, and the action of the acid chloride upon the primary amide; the latter gave better yields. The properties of dibutyramide, diisobutyramide, divaleramide, and diisovaleramide are described.—The action of ammonium persulphate upon metallic oxides, by MM. A. **Seyewetz** and P. **Trawitz**.—The action of bromine upon pinene in the presence of water, by MM. P. **Genvresse** and P. **Faivre**.—The influence of the nervous system on the ontogenesis of the limbs, by M. P. **Wintrebert**. From the experiments described the conclusion is drawn that the nervous system is not necessary in the production of the limb, neither for its growth, general morphogeny, nor for its differentiation.—The geographical distribution of the Coleoptera (Bostrychides) with respect to the food requirements of these insects, by M. P. **Lesne**.—On a lactic diastase capable of hydrolysing salol, by MM. A. **Miele** and V. **Willem**. The authors regard the existence in milk of a ferment capable of hydrolysing salol as doubtful.—On the modifications in respiration due to age, with especial reference to the guinea-pig, by M. Léopold **Mayer**.—On the variation of *Bornetina Corium* according to the nature of the medium, by MM. L. **Mangin** and P. **Viala**.—The influence of common salt on the transpiration and absorption of water in plants, by M. H. **Ricôme**.—On a bud graft on the lilac, by M. Lucien **Daniel**.—The presence of cordierite in the eruptive products from Mont Pelée and Mont Soufrière at St. Vincent, by M. A. **Lacroix**.—The origin of the folds in the Pyrenees, by M. Joseph **Roussel**. —Experimental researches on dreams. The relation between the depth of sleep and the nature of the dreams, by M. N. **Vaschide**. In light sleep the dreams have reference to things which occurred immediately preceding sleep, but in profound sleep the dreams have no reference to recent events.

CONTENTS. PAGE

THURSDAY, JULY 30, 1903.

A MODERN PHYSICIST.

Scientific Papers of Lord Rayleign. Vols. ii., iii. and iv., 1881–1901. Pp. xiv+598; xii+596; xiv+604. (Cambridge: University Press.)

TO review these volumes in an ordinary sense is an impossible task. Fortunately it is quite unnecessary. Lord Rayleigh's work in its many phases is so well known that a brief notification of the fact that his papers have been collected and published by the Cambridge University Press is almost all that is called for. Every physicist will realise that his library is incomplete without these four splendid volumes, the first of which has already been noticed, and that he will find in their pages the details of many of the most striking advances in his subject during the past twenty years.

Lord Rayleigh succeeded Maxwell as professor of physics at Cambridge in 1879. The first volume under notice opens with his classical work in the Cavendish Laboratory on the electric units; the latter pages of vol. iv. deal with his experimental verification of Boyle's law for pressures down to the hundredth of a millimetre. A list of the papers—272 in number in the four volumes—would cover the whole range of physics, and each contains a contribution of real value to natural knowledge.

During his tenure of the Cambridge chair, Lord Rayleigh undertook the determination of the three fundamental units of electrical science, the ohm, the ampere, and the volt.

> "It is generally felt," he writes in the first paper (*Proc.* Roy. Soc., 1881), "that considerable uncertainty still attaches to the real value of the ohm or British Association unit of resistance. The ohm was constructed to represent 10^9 C.G.S. units of resistance, but according to Kohlrausch it is nearly 2 per cent. too great, and according to Rowland nearly 1 per cent. too small."

The ohm, thanks to the work of Lord Rayleigh and those who have followed in his steps, is now known to some few parts in ten thousand.

It is much the same with the ampere and the volt; more recent work has shown that possibly some small change is required in the numbers given by Lord Rayleigh to represent the electrochemical equivalent of silver and the electromotive force of a Clark cell, but the change will be very small. His work made the Clark cell a practical standard, and every electrician now knows its value. The H form of cell is first described on p. 315 of the second volume of the papers.

But this series of papers did not exhaust his experimental work at Cambridge; the researches on the value of the ohm would have been incomplete without the determination of the specific resistance of mercury (Article 81) by Mrs. Sidgwick and himself. The experiments on the rotation of the plane of polarisation of light in a magnetic field were planned at first in the hope of utilising the results in the measurement of an electric current, and though this hope was not realised, they remain as the standard determination of Verdet's constant. A second paper on the Clark cell is dated 1886.

A short paper (No. 92) from the *Philosophical Magazine*, vol. xiv., 1882, will serve as an example of Lord Rayleigh's work as a critic. It is a comparison of the methods for the determination of resistances in absolute measure, and affords a most valuable *résumé* of the methods employed.

Resistance being on the electromagnetic system of the dimensions of a velocity, the measurement of a length and a time are necessary; the principal length involved is nearly always the mean radius of a coil, and the presumption is in favour of the method which involves only a single linear measurement.

The paper exhibits in a marked degree Lord Rayleigh's great capacity for seeing distinctly the essential point of an experiment or a measurement, and keeping that clearly in view throughout. This, indeed, is the distinguishing feature of his experimental work, a main factor in his success. Those who knew the Cavendish Laboratory when the electrical measurements were going on, or have since visited the laboratory at Terling, from which no less important work is continually being published, have sometimes been surprised at the makeshift character of much of the apparatus. Contrivances of wood and wire and wax do duty where most men would use apparatus elaborated with a quite unnecessary care; but in Lord Rayleigh's case, while the essential instrument on which the accuracy of the result really depends is as perfect as the skill of the workman can make it, and, in addition, has been thought out in all its details so as to fit it best for the purpose immediately in view, for the rest the arrangement which comes first to hand is utilised without regard to appearances.

In addition to the fundamental measurements already referred to, the Cambridge years were marked by a series of optical papers of great value. Among these may be mentioned the article on optics for the ninth edition of the "Encyclopædia Britannica," in which the theory of the resolving power of an optical instrument is given in a simple manner.

The papers already mentioned are contained in vol. ii. of the collected works. Those in vol. iii., written after Lord Rayleigh had resigned the Cambridge chair, differ somewhat in character, but are no less interesting. The article on the wave theory of light from the "Encyclopædia Britannica," and the papers on the relative densities of hydrogen and oxygen, and the composition of water, Articles 146, 153, 187, are perhaps the most important.

Attention may also be directed to a series of papers on capillary questions, while Article 191, on the physics of media that are composed of free and perfectly elastic molecules in a state of motion, has a special interest. Waterston had communicated to the Royal Society in 1845 a paper with the above title, which remained unpublished until 1892, when Lord Rayleigh's attention was directed to it, and the paper was printed in the *Phil. Trans.* with an introduction by himself. Waterston was the first to introduce into the kinetic theory the notion that heat and temperature are to be measured by the kinetic energy of the moving particles. From

this he deduces the law of Dalton and Gay Lussac, and he further establishes, though in an incomplete manner, the law that in mixed gases the mean kinetic energy is the same for the different sets of molecules present, from which Avogadro's law and Graham's law of diffusion follow at once. The memoir also contains the first calculation of molecular velocity, and points out the relation of this velocity to the velocity of sound.

The papers on the relative densities of hydrogen and oxygen find a fitting sequel in some of the earlier papers of the fourth volume, the first of which is on the density of nitrogen, Article 197. This begins:—

"I am much puzzled by some recent results as to the density of nitrogen, and shall be obliged if any of your chemical readers"—the article is a letter to this Journal, NATURE, vol. xlvi. pp. 512, 513, 1892—"can offer suggestions as to the cause. According to two methods of preparation I obtain quite distinct values. The relative difference, amounting to about 1/1000 part[1] is small in itself, but it lies entirely outside the errors of experiment, and can only be attributed to a variation in the character of the gas."

And the paper concludes:—

"Is it possible that the difference is independent of impurity, the nitrogen being to some extent in a different (dissociated) state?"

The matter is again referred to in the Royal Society paper, No. 201, on the density of the principal gases, published in the *Proceedings* of 1893, and in detail in Article 210. On an anomaly encountered in determinations of the density of nitrogen gas (*Proc.* Roy. Soc., 1894), when it appeared that while the weight of nitrogen derived from the air required to fill a certain globe under standard conditions was 2·3102 grammes, when the nitrogen was obtained as a chemical product from other sources than the air the weight was 2·2990 grammes, a difference of 11 milligrammes, or one-half per cent. The question was answered satisfactorily by the paper which appears as No. 214, "Argon, a New Constituent of the Atmosphere," by Lord Rayleigh, Sec.R.S., and Prof. William Ramsay, F.R.S. (*Phil. Trans.*, clxxxvi., A, 1895), and an interesting account of the discovery is contained in the Royal Institution lecture on argon, which forms Article 215.

The *Phil. Trans.* paper contains the account of the means used to separate from the nitrogen of the air the new dense gas the presence of which Lord Rayleigh had discovered, as a residual, by the accuracy of his weighings.

A number of further papers dealing with argon and some of the other new gases are contained in this volume. One of the latest is on the verification of Boyle's law for low pressures. There is also much valuable optical work, specially, perhaps, Article 198, on the intensity of light reflected from water and mercury at nearly perpendicular incidence, and many important investigations of a mathematical character on the electromagnetic theory of light. Among these may be noted Article 227, on the passage of waves through apertures in plane screens, and Article 230, on the incidence of aërial and electric waves on small obstacles.

[1] The difference ultimately found was 1/200.

Perhaps enough has been written to convey to readers who are not professed students of physics the width of range and the power of Lord Rayleigh's work, and to unite them with those who look to him as their leader and master in thanking him for collecting his papers in these four volumes, and rendering them accessible to all.

It is almost needless to add that the University Press has done its part admirably, and fully deserves the thanks of students of nature for its share in the work.

Within a few years the Cambridge Press has published the collected works of Adams, Cayley, Maxwell, Stokes, Tait, Kelvin, Reynolds, and Rayleigh, men whose names will ever make the Cambridge school of mathematics and physics of the last half of the nineteenth century famous in the history of science.

MICRO-ORGANISMS IN THE ARTS AND MANUFACTURES.

Technical Mycology: the Utilisation of Micro-organisms in the Arts and Manufactures. By Dr. Lafar. Translated by C. T. C. Salter. Vol. ii. *Eumycetic Fermentation,* Part i. Pp. viii+189. (London: C. Griffin and Co., Ltd., 1903.)

THE first volume of Mr. Salter's translation of Dr. Lafar's "Technical Mycology," which made its appearance some four or five years ago, opened up to the general reader a very wide and interesting field, the utilisation of micro-organisms in the arts and manufactures. This volume dealt with schizomycetic fermentation, and to the uninitiated who had not looked into the scheme of the whole work, it appeared as though almost the last word must have been said on fungi and fermentation.

The first part of the second volume, the advent of which has been eagerly awaited, has now come to hand, and we may say at once that in many ways it is equal to the first volume and that, not only have we the results of the author's own experience and observations, but a *résumé* of the results of others well brought up to date. This volume deals with the eumycetic fermentation and opens with a series of chapters on the rudiments of the general morphology and physiology of the Eumycetes, chapters of as great interest to the general biologist as to the bacteriologist and fungologist. A short description of the structure of the Eumycetes is given, the method of spore formation, the development of the mycelium from the spore, the gemmating mycelium, and the various methods of reproduction—fructification by sporangia, zygospores, conidia, or by the formation of oidia and gemmæ without the intervention of conidiophores. The author refers the reader for more detailed accounts of structure and function to the early text-books provided by Zopf, De Bary, and Brefeld, but supplements these works by carefully written chapters on certain parts of the subject on which much work has been done since the appearance of these text-books. He describes the researches which have been carried out on the celluloses, chitin, hemicelluloses, and other carbohydrates of which these fungi are composed, dis-

cusses the position of their colouring matter and ascribes the waterproof character of certain cell membranes to the deposition of excreted fatty or waxy substances, pointing out that this waterproof character is of importance biologically,

"since it prevents the penetration of toxic substances from the surrounding aqueous medium, and thereby also opposes the attempts of the mycologist to kill such fungi by means of aqueous toxic solutions."

A chapter is devoted to the mineral nutrient matter utilised by the Eumycetes, the author indicating that certain substances which are not absolutely necessary for the nutrition of these organisms may still, as in the case of nickel, cobalt, and manganese, like iron, exert a stimulative action on the growth of fungi. Sulphur, selenium, and silicon may also be found in the protoplasm of these fungi, but phosphorus appears to be a most important element in their composition, and, although arsenic does not take the place of the phosphorus in the Eumycetes, certain of these organisms appear to have the power of converting arsenious acid into volatile compounds having an odour of garlic. These organisms have, therefore, been used for the purpose of indicating the presence of arsenic in cases where, by the ordinary Marsh's tests, only a doubtful reaction has been obtained. The influence of light on the development of the Eumycetes is discussed, and it appears that although strong light interferes with their development, moderate illumination interferes very little with their activity. Chemotropism is discussed somewhat fragmentarily; this remark applies also to the diastatic enzymes and the enzymes capable of decomposing fat; the enzymes of yeast, however, are described more fully in the later part of the work.

The special part of the book consists of two sections, one devoted to the fermentation set up by Zygomycetes, the other to a preliminary consideration of yeast-fermentation. The first of these sections is interesting to the technologist from the fact that it deals with Calmette's *Amylomyces Rouxii* or *Mucor Rouxii*, derived from the Chinese yeast-balls used in the preparation of rice spirit. This produces a powerful diastatic enzyme which first produces glucose, and this, in the absence of oxygen, is converted by yeast ferment into alcohol. For a full account of the Amylomyces process the reader may be referred to the description of the use of the Mucoreæ in the spirit industry.

The latter half of part i. of vol. ii. is devoted entirely to yeasts, especially the forms, structure, and chemical composition of the yeast-cell, and anyone who studies this will be amply repaid by obtaining a knowledge of the principles and mechanism of fermentation such as can be obtained elsewhere only by the study of bulky treatises, though now and again one is a little disappointed that the author has not elaborated his descriptions somewhat more fully, this remark applying specially to the chapter on the chemistry of the yeast-cell. The sketch given is so interesting that one would have welcomed a somewhat more detailed account of this part of the work.

After reading this work one feels the truth of Hansen's statement that none of the text-books and manuals giving a summary of larger or smaller sections of technical microbiology has treated the subject of this extensive field from so comprehensive a point of view as that of Dr. Lafar. In preparing the work, the author has exhibited not only many sided discernment and enthusiasm for his task, but also great courage and endurance. Certainly, this part of the second volume

"will be welcomed not only by those for whom it is primarily intended, viz., technical chemists, chemists dealing with food stuffs, fermentation and agriculture, pharmacists, and agriculturists, but many another worker will derive benefit from its pages for his lectures and researches."

We can cordially recommend this section of Dr. Lafar's work as an excellent supplement to the first volume, which has already been reviewed in our columns.

We are glad to learn that the translators have made arrangements with the German publishers to obtain advance proofs of the German work in order that the concluding sections may appear as soon as possible. This portion of the work fully maintains the interest aroused by the first volume, and the translators are to be congratulated on the fact that they have been able to give so accurately not only the substance, but the spirit of the German work.

G. SIMS WOODHEAD.

VISUAL PURPLE.

Abhandlungen zur Physiologie der Gesichtsempfindungen. By J. von Kries. Heft. i., 1897, pp. vi+198; Heft. ii., 1902, pp. 197. (Leipzig: Johann Ambrosius Barth.)

THIS is a collection of papers reprinted from the *Zeitschrift für Psychologie und Physiologie der Sinnesorgane.* The papers are the work of von Kries and his school, and deal chiefly with visual purple and its functions. They give an account of one of the most important of recent advances in our knowledge of the physiology of sensation.

The discovery of visual purple in 1876 aroused great hopes, which seemed to be frustrated when it was found that the substance was absent from the *fovea,* the place of most distinct vision, and physiologists soon settled down to the view that a substance absent from this situation could have little to do with the production of visual sensations.

In the early days, however, Kühne suggested that the great instability of visual purple made it probable that it was a substance for the perception of feeble light, and Parinaud in France later advanced the same idea. It has been reserved for von Kries to develop fully Kühne's idea.

According to von Kries, visual purple is a substance which supplies the retinal basis for vision at low luminosities, and the accumulation of this substance is accountable for the great increase in sensitiveness of the dark-adapted eye—a thousand-fold increase according to some computations.

The change in the relative brightness of different colours with varying illumination, first pointed out by Purkinje, finds a ready explanation on this view.

Hering had shown that this phenomenon is a function of the condition of dark-adaptation produced by feeble illumination rather than a function of the feeble illumination itself, and von Kries shows that the changes of relative brightness are readily explicable if we suppose that, as the eye becomes more and more dark-adapted, there comes into play a new factor which has no influence, or no appreciable influence, at ordinary luminosities. Speaking roughly, the blue end of the spectrum becomes relatively brighter, and it is this end of the spectrum which has the greater action on visual purple.

In pronounced dark-adaptation the spectrum is seen as a colourless band of light, and the curve of luminosity of the spectrum in this condition shows a close correspondence with the curve representing the degree of action of different parts of the spectrum on visual purple. The spectrum is shortened at the red end; it is brightest in the green, and the diminution of brightness towards each end is much more gradual on the blue than on the red side of the maximum.

Visual purple also furnishes an explanation of an anomaly of colour vision which has long puzzled physiologists. A colour-equation which is good for one luminosity is not good for all luminosities, and von Kries shows that the mixed light which becomes relatively brighter at low luminosities is that which has the greater action on visual purple.

The absence of visual purple from the *fovea centralis* provides a ready method of putting the theory to the test. If dark-adaptation with its influence on colour-brightness and colour-equations be due to visual purple, the *fovea* should not share in the increased sensitiveness of the dark-adapted eye, nor should this region show any change in colour-brightness or in colour matches in different conditions of adaptation.

There seems to be no doubt that the *fovea* responds in favour of the theory. There is some difference of opinion as to whether this region fails entirely to show alteration of sensitiveness, but it is generally agreed that any increase which occurs is insignificant compared with that of the surrounding region of the retina. Very careful observations by Nagel and others seem also to show conclusively that Purkinje's phenomenon and the alteration of colour-matches are absent if the stimulation of the retina be strictly limited to the foveal region. The features of colour vision which are believed to depend on visual purple are absent just when, according to the theory, they should be absent.

One of the most interesting developments of the theory is that in which the condition of total colour-blindness is regarded as vision dependent chiefly, or exclusively, on the visual purple of the rods. Hering was the first to show that the curve of luminosity of the spectrum in most cases of total colour-blindness corresponds with great exactness to the curve of luminosity of the normal dark-adapted eye, and von Kries shows that there are other points of close resemblance between the two conditions.

If visual purple be the basis of monochromatic vision, there ought to be a central blind spot, and in several cases which have been examined from this point of view by quite independent observers, this has been found to be the case. Again, the behaviour of the *fovea* is in favour of the theory. The evidence here, however, is not unanimous. Hess has failed to demonstrate the existence of a central scotoma in several cases, but our knowledge of the exact distribution of rods and cones in the human *fovea* is based on very few examinations, and it is possible that there are wide individual variations, and that in some people an area devoid of rods may be absent, or so small that it is impossible to demonstrate its presence. The diffusion of visual purple into the rod-free area is also possible in some cases, but it seems more probable, from a study of the evidence as a whole, that there are two kinds of total colour-blindness, and that in only one of these is it probable that visual purple is the only sensitive substance in the retina.

Several of the papers in the "Abhandlungen" deal with the recurrent image, or "ghost" of Bidwell, which is believed by von Kries to be a "visual purple" phenomenon. This part of von Kries's work has been much attacked, and recent work seems to show that the recurrent image is a much more complex phenomenon than has usually been supposed. It is probable that visual purple is only the basis of one of the elements of the complex.

The comparative evidence is in favour of the theory, visual purple being abundant in nearly all vertebrates the habits of which are nocturnal or which live underground.

It has only been possible here to give the briefest sketch of the views of von Kries and his co-workers. The "Abhandlungen" should be consulted for the elaborate investigations and detailed arguments in support of their views.

W. H. R. RIVERS.

OUR BOOK SHELF.

Botanische Forschungen des Alexanderzuges. By Dr. H. Bretzl. Pp. xii+412. (Leipzig: Teubner, 1903.) Price 12 marks.

THE criticism passed by Sachs in his "History of Botany" on the writings of the ancient classical writers, including Theophrastus, seems to have been unnecessarily severe where he passes over their "corrupt texts" with a brief mention. At that time the study of geographical and ecological botany had not received the stimulus which was mainly induced by the appearance of Schimper's master work, "Die Pflanzengeographie." It would hardly be going too far to say that it required the development of this branch of the subject to admit of the full appreciation of Theophrastus's work. For the essential feature of Theophrastus's "Plant Geography," and this book is the main source of information concerning Alexander's expedition, is the painting of a series of word pictures, illustrations of types of vegetation, in which, while correct morphological ideas could hardly be looked for, the descriptions, in their accuracy of observation and power of expression, are not often excelled by those due to present-day writers. As might be expected, some of the accounts are difficult of explanation, and discrepancies arise which have demanded considerable skill and enthusiasm on the part of Dr. Bretzl to clear up. Others are more obvious; thus the paragraph which begins:—

"*ὑποβέβρωται δὲ ταῦτα τὰ δένδρα πάντα κατὰ μέσον ὑπὸ τῆς θαλάττης καὶ ἕστηκεν ὑπὸ τῶν ῥιζῶν ὥσπερ πολύπους*" calls up very definitely the picture of a mangrove swamp.

Even more striking is the description of a mimosa which grew near Memphis:—"ὅταν δέ τις ἅψηται τῶν κλωνίων ὥσπερ ἀφαναινόμενα τὰ φύλλα συμπίπτειν φασίν, εἶτα μετά τινα χρόνον ἀναβιώσκεσθαι πάλιν καὶ θάλλειν."

Here the difficulty arises with regard to the species which is denoted, but special investigation by Dr. Schweinfurth elicited the information that in the vicinity there grows *Mimosa asperata*, a plant the sensitivity of which is almost unknown to botanists. Another graphic description is that of the banyan, συκῆ 'Ινδική, with the allusion to the roots developed from the branches, which are roots because they are lighter in colour and *leafless*. But the book contains many similar points of interest, and Dr. Bretzl has furnished abundant proof of the accuracy of perception and faculty of discernment possessed by some of the ancient Greeks.

The sources of information are to be traced to the memoirs of certain of Alexander's retinue. These manuscripts, which were deposited in Babylon, have unfortunately been lost; but they were apparently available to Theophrastus, who has worked up the material with truly remarkable intuition. Between the writings of Theophrastus and those of other authors, notably Pliny, Dr. Bretzl draws a sharp line of distinction, the distinction, in fact, between the original thinker and the annotator.

Practical Plane and Solid Geometry for Elementary Students. By Joseph Harrison. Pp. xiii + 250. (London: Macmillan and Co., Ltd., 1903.) Price 2*s*. 6*d*.

THIS little book will be found very useful for the teaching of the fundamental principles of geometry to young students. The most important properties of triangles and other plane figures are illustrated by means of accurate drawing and numerical calculation, and thus appeal more readily to the understanding and memory than if the beginner were made acquainted with them by means of the severe and tedious logic of Euclid. The great advantage of such a book as this is that it prepares the mind of the beginner for methods of accurate logical demonstration at a later stage in his studies. The very large number of numerical exercises requiring calculation and the use of instruments should suffice to give the student a very firm knowledge of all the important part of elementary geometry; and for this reason the book can be confidently recommended to teachers.

The first ten chapters are of this useful kind; then follow some chapters on the nature of vectors and their addition, including some properties of uniplanar forces acting on a particle the necessity for which may, perhaps, be doubted. In these chapters we meet with a little careless writing which, doubtless, will be corrected in the next edition. Thus, the first sentence (or what should be a sentence) on p. 118 reminds us of Mr. Skae's item in "The Jumping Frog": a verb is missing and no assertion is made. The use of the expression "in *tandem*, or *follow-my-leader*" to indicate cyclic order in the sides of a triangle is of doubtful propriety; but such trifles constitute, of course, no serious objection.

The notation l_{θ} for the magnitude and direction of a vector (p. 130) is distinctly useful in the composition of vectors. Chapter xiii., on concurrent forces, will, of course, be omitted by the beginner whose aim is to acquire only a knowledge of the elements of geometry; and it scarcely belongs to the subject.

The remaining five chapters deal with geometrical drawing in three dimensions, and they constitute a very good introduction to the subject, the figures being very numerous, and accompanied by a large number of numerical examples.

Die Aluminium-Industrie. By Dr. F. Wintelen. Pp. xi + 108. (Braunschweig: Friedrich Vieweg und Sohn, 1903.) Price 6 marks.

THIS very interesting monograph upon the aluminium industry commences with a short historical introduction, in which we learn that Davy, so far back as 1808, after he had discovered sodium and potassium, endeavoured to prepare aluminium by electrolysing alumina. In this he was not successful, and it fell to the lot of Wöhler in 1827 first to prepare the metal by purely chemical methods. Bunsen, however, was able in 1854 to obtain it by electrolysing its chloride. In a table on p. 5 the variation in the price of the metal is traced since 1854, when it was merely a chemical curiosity. Its value in that year was 120*l*. per kilo, and even in 1889 it cost 2*l*.; but with the improvements of the electrical methods, the price rapidly dropped, until in 1901 it ranged from 2*s*. to 2*s*. 6*d*. per kilo. Following the historical portion of the work, a very full account of the physical and chemical properties of the metal is given. It is not until we reach p. 22 that the present methods of obtaining the metal are gone into, but here the thoroughness of the treatment leaves nothing to be desired. In the first place a careful account of the preparation of the outgoing materials used in the manufacture is given. This part of the work is of very considerable value. Everyone is aware that bauxite and cryolite are the substances used for preparing aluminium, and those who have studied the subject know that these substances cannot, as a rule, be employed without being first purified. In this book the methods of purification are described in detail, and methods of analysis are also set forth. Page 54 is headed "carbon electrodes"; these are employed both for the anode and kathode, in consequence of impurities introduced into the bath when other electrodes are used. The author gives details of the manufacture of these carbon electrodes—ten pages are devoted to this. Some useful diagrams illustrating the way in which the electrodes become corroded during the electrolysis are also given.

The last few pages of the monograph are devoted to the "working up of the metal"; one of the most interesting points being the method for welding the metal which is employed by Heräus, of Hanau. It consists in heating aluminium sheets with a hydrogen flame to a temperature of about 400°. The edges are then pressed together, and after being worked for some time with the hammer, they weld together in such a manner that tubes made in this way can hardly be distinguished from seamless ones.

This monograph is one of the most interesting and useful which we have had the pleasure of reading for a long time. The facts are well arranged, and although there are 108 pages devoted to the single subject of the aluminium industry, we do not consider that the work suffers from prolixity; we wish this could be said of many German monographs which have lately been published.

F. M. P.

Die Konstitution des Kamphers und seiner wichtigsten Derivate. By Ossian Aschan. Pp. xi + 117. (Braunschweig: Friedrich Vieweg und Sohn, 1903.) Price 3.50 marks.

THE chemistry of camphor and its derivatives has occupied the attention of chemists for many years, and has now become so specialised that it is almost impossible for the ordinary chemist to keep up with the immense amount of research published in the journals devoted to chemistry. The monograph by Prof. Aschan is accordingly very welcome, and will be found useful not only by the non-camphor chemist, but also

by the camphor specialist. The treatment of the subject is purely theoretical, and in that respect differs from the valuable paper "On the Constitution of Camphor" read at the British Association in 1900 by Dr. Lapworth.

A short introduction is followed by a chapter giving a *résumé* of the various camphor formulæ arranged in historical order, starting from that proposed by Victor Meyer in 1870 and coming down to that of Schryver in 1898. This history of camphor formulæ is an interesting example of evolution. The formula proposed by Bredt in 1893, and now generally accepted, seems best to explain the constitution of camphor and its numerous derivatives, and is the one adopted by the author.

In the third chapter the practical data on which the constitution of camphor rests are recorded under twelve heads, such as "camphor is a ketone," it "contains the group $.CH_2.CO$," "camphor and camphoric acid are saturated compounds," &c., all of which conditions are fulfilled by the Bredt formula. In this connection, to the researches of Brühl on the refractive index might have been added those of Perkin on the magnetic rotation, as confirming the bridged ring structure of camphor. The inconsistencies of other formulæ with the above-mentioned facts are briefly pointed out in the fourth chapter. The degradation products are next treated, and the monograph finishes with a discussion of the constitution of camphene and bornylene.

The clear manner in which Prof. Aschan indicates how some of the many seemingly inexplicable reactions probably take place is worthy of comment. The difficulty of excluding unimportant details and including all that is important in such a monograph as the one under notice has been overcome by the author with great success. J. E. M.

Theorie der Bewegungsübertragung. By Richard Manno. Pp. iv + 102. (Leipzig: Engelmann, 1903.)

IN laying down the fundamental notions of mechanics there has been divergence of opinion concerning the definition of force. There is the distinction between cause and effect, between statics and dynamics. The older school has regarded force as the cause of motion, modern theorists prefer to define and measure force by the effect only. Herr Manno attempts to construct a system of mechanics by regarding force as neither cause nor effect, but as the phenomenon of motion itself, and further, in order to get rid of the notion of action at a distance, every instance of force is supposed to be due to impact, so that motion is transferred from body to body by a succession of intervening impacts. Accordingly the attempt is made to develop the theory of impulsive forces from the simple cases of direct and oblique impact. Naturally, in this view, some divergence is found from the ordinarily accepted theory. The proportionality of cause and effect as implied in the "second law of motion" obviously fails when the momentum of a striking body is regarded as producing the momentum of a struck body.

It must be confessed that the author's theory, when its meaning is disentangled from the mass of verbiage with which it is swathed, does not seem to smooth the way towards a clear apprehension of the principles of mechanics. His leading idea seems to be that purely theoretical conceptions, such as action at a distance, must be discarded, and that all the terms used must represent observable phenomena. The author probably has in his mind the subject of a discussion recently appearing in NATURE, as is evidenced by sundry physiological allusions, and his objection to the technical meaning of "work" when applied to living organisms. R. W. H. T. H.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On a Map that will Solve Problems in the Use of the Globes.

IN mapping an extensive region of the earth in separate sheets, there are great advantages in dividing the region into belts by parallels of latitude, and modifying the law of representation in passing from each belt to the next. This plan is illustrated by the accompanying sketch, which represents a region extending from the equator to the North Pole, and covering 80° of longitude.

The map consists of nine sheets, each covering 10° from north to south, and 80° from east to west. The meridians are indicated at every tenth degree, and are straight lines, all of the same length, at right angles to the parallels of latitude, which are arcs of circles. The two parallels which bound each sheet are on the same scale as the meridians, so

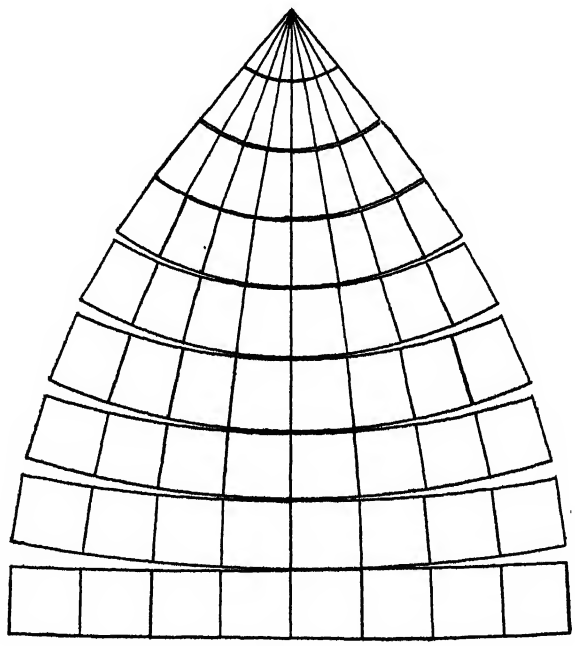


FIG. 1.

that the four sides of each of the seventy-two compartments of the map are precisely equal to the lengths which they represent on a spherical globe; and no difference is made between extreme and central meridians, all longitudes being treated alike. The intermediate meridians and parallels will be at right angles, as well as those shown, and the meridians will be of correct length. The intermediate parallels will be a trifle too short, the defect amounting, in the case of the middle parallel of each sheet, to rather less than 1 part in 250, a difference too small to be detected by the eye.

In examining on the map the borderland of two sheets, the two sheets are to be placed in contact at any point on the parallel common to both, and then, on rolling the edge of one sheet against that of the other, the whole border region from end to end will pass in review. All the successive meridians, when they are brought in turn to the point of contact, will be seen as straight lines crossing the point of contact, and the same will be true for the two portions of any oblique line which crosses the boundary.

If we want to trace a great-circle route from one place to another, we have merely to roll the sheets into such positions that the points of contact lie in a straight line

drawn from one place to the other. This straight line will represent the great-circle route.

I have put this matter to experimental test by constructing (on the scale of a 20-inch globe) eighteen cards, consisting of two sets of duplicates, and the accompanying figure is a reduced copy of one set.

As all meridians are treated alike, one card can be shifted 10°, 20°, 30°, &c., east or west relative to another, and this is necessary when the difference of longitude of the two places exceeds 80°. The second set of cards can either be used for the southern hemisphere or for increasing the range of longitude to 160°. I can thus measure the great-circle distance from London to Shanghai (the route passing 1½ degrees north of St. Petersburg), or from Yokohama to San Francisco, or from Land's End to Cape Horn. For measuring the distances I use a card scale divided into degrees of the same length as the degrees of the meridian.

The process above described also serves for finding the position of the sun in the sky at a given hour of the day, and by obvious modifications of it, most of the problems set forth in books on the use of the globes can be solved. In dealing with a spherical triangle, two of the sides are represented by polar distances, the included angle by difference of longitude, and the third side by the divided scale.

J. D. EVERETT.

Action of Tesla Coil on Radiometer.

THE following phenomena, observed while experimenting with a small Tesla coil, will, I believe, interest some of your readers. Not having access to the necessary literature, I am not in a position to find out whether they are new or already known.

The knobs of the Tesla coil were placed in contact with, or just close to, the bulb of a Crookes's radiometer, and the coil set at work. When the brush discharge fell upon the bulb, the blackened surfaces of the vanes first retreated, as they do under the influence of radiant heat, but soon the direction of rotation changed, and the blackened surfaces moved forward, the motion continuing as long as the brush discharge fell upon the bulb.

At the same time, inside the bulb, were seen diverging from the glass sides close to the knobs two cones of pale blue light; which, falling on the opposite sides of the bulb, caused a yellowish-green fluorescence. On the fluorescent parts the shadows of the rotating cones were clearly visible, the shadow on one side being always more intense than on the other side. When the direction of the current in the charging Ruhmkorff was reversed, the shadows exchanged places, but no change in the direction of rotation of the vanes was noticed.

On examining the fluorescent parts with a screen of potassium platinocyanide, the same effects were noticed as with the X-ray tubes.

Similar effects were obtained on repeating the experiments with two incandescent lamps in the laboratory. The larger of these, an old Swan lamp, fluoresced green, and the smaller new one, supplied with the Tesla coil by the manufacturer, fluoresced blue. But in both cases, though somewhat feeble, the same X-ray effects were observed.

To study further the cause of the motion of the vanes of the radiometer, the experiment was repeated with a Crookes's tube containing a freely suspended wheel with transparent mica waves. In this case it was found possible to alter the direction of rotation of the wheel by adjusting the positions of the knobs of the Tesla coil relatively to the sides of the tube and the wheel inside it.

P. L. NARASU.

Christian College, Madras, June 18.

Tides at Port Darwin.

ALONG the north-west coast of Australia the tidal wave, flowing in from the Indian Ocean, produces at most places a large rise and fall. At Port Darwin the mean spring range is about 24 feet, but the range is sometimes as much as 30 feet. A tide gauge of Lord Kelvin's pattern was set up here by the South Australian Government some few years ago, and good records are available up to 1897, since when it has been dismantled, waiting the building of a new jetty. Captain Inglis, the harbour-master at Port Adelaide, and the writer selected the last good records available for a whole year's tides, the records beginning January 1, 1896, and subjected them to a harmonic analysis, with the results given in the table below. The records show a very marked diurnal inequality, especially at the low waters. In the year examined the greatest difference in height between the two high waters occurred in January and December, and amounted to 4 feet 9 inches. In April, however, there was a difference in height of the two low waters of as much as 10 feet. The analysis shows the existence at Port Darwin of a remarkably large annual tide, the water on this account standing nearly two feet higher at the end of summer than it does at the end of winter. At first sight this seems very remarkable, especially when we find that at Kupang, on the island of Timor, to the north, according to Van der Stok, the solar annual tide has a semi-range of only 2·3 centimetres. The tide appears to be a purely meteorological effect due to the conformation of the harbour and the direction of the prevailing winds. The harbour opens towards the N.W., and, as will be seen from a perusal of the wind charts given in Van der Stok's work, "Wind and Weather, Currents, Tides and Tidal Streams in the East Indian Archipelago," the winds during the summer blow with great persistency from the N.W., tending to pile the water up in the harbour, while in the winter time the prevailing winds are S.E., with, of course, an opposite effect. This is further assisted by the variations of atmospheric pressure. The average barometer readings exhibit a remarkably regular annual fluctuation, as is shown by the following results. The averages are from readings taken at regular intervals of three hours for twenty years, ending 1901:—

	Mean Readings for 20 years.	Mean Readings for 1896.
January	29·765	29·757
February	29·769	29·759
March	29·814	29·808
April	29·863	29·849
May	29·917	29·973
June	29·945	29·966
July	29·966	29·969
August	29·956	30·005
September	29·931	29·978
October	29·892	29·948
November	29·841	29·868
December	29·793	29·854

Results of Harmonic Analysis of Records of Tide Gauge at Port Darwin (Latitude 12° 23′ S., Longitude 130° 37′ E.) for the year beginning noon, January 1, 1896.

Component.	Amplitude.	Phase (K).	Component.	Amplitude.	K.
	Feet.	°		Feet.	°
S_1	0·16	169	Q	0·34	324
S_2	3·44	193	μ	0·39	110
S_4	0·05	127	P	0·44	1
S_6	0·01	184	K_1	1·91	336
M_1	0·05	315	T	0·24	166
M_2	6·56	144	R	0·83	97
M_3	0·05	26	K_2	1·02	204
M_4	0·13	279	2SM	0·17	13
M_6	0·06	167	MS	0·16	30
N	0·40	121	*Sa*	0·97	76
L	0·41	216	*Ssa*	0·54	58
ν	0·96	161	*Msf*	0·47	29
O	1·14	313	*Mf*	0·128	333
J	0·14	197	*Mm*	0·045	284

The University, Adelaide. R. W. CHAPMAN.

Spirals in Nature and Art.

I HAVE to thank you for a very kind notice of my little essay on spirals, and I venture to trouble you further on the subject, because your last paragraph, criticising my attribution of spiral curves in flight to Leonardo, gives me an opportunity of making a correction to which, I feel sure, your courtesy to a distinguished scientific writer will enable me to give publicity. It appears that, in pp. 153 to 155 of my study of spirals, and in the figures 45 and 46 therein included, I have unconsciously done an injustice to the original researches on flight published by Dr. J. Bell Pettigrew, M.D., LL.D., F.R.S., Chandos professor of medicine and anatomy at the University of St. Andrew's, who, I now find, has been steadily engaged on the problem of flight since 1867, and has apparently published many papers and memoirs on the subject in the *Proceedings* of the Royal Institution of Great Britain, the *Transactions* of the Linnean Society and of the Royal Society of Edinburgh, and elsewhere.

My figure 45, which you acutely ascribe to its right author, is of very little importance to my argument, and only a side-issue in my essay, but it is right to say that it is Dr. Pettigrew's original figure, and should have been acknowledged as such in my pages. Had I known of this, I think I need hardly assure you that this acknowledgment would have been inserted, and that Dr. Pettigrew's own explanation of the figure would have been substituted for what he would justly stigmatise as the incorrect explanation given in my text. I have also to add that Prof. Marey's photograph of a flying pigeon, which I attributed to the only source I knew, was really an illustration of the alternate and opposite rise and fall of the body and the wings of a bird in flight, a principle first described and figured by Dr. Pettigrew in his memoir on "The Physiology of Wings" (*Trans.* Roy. Soc. Edin., 1870), and acknowledged by Prof. Marey as a previous discovery.

THEODORE ANDREA COOK.

Distribution of Calostoma.

IN December, 1891, I found in a pit near Port Katsura, a few miles off this place, a species of Calostoma in abundance, and this year I see the same fungus now and then occurring here. I send you some specimens of it herewith, in the hope that some mycologist of your acquaintance may determine it in my behalf. Of all the species given in Mr. Massee's monograph of the genus in the *Annals of Botany*, vol. ii. 1888, it seems most near *C. Ravenelii*, Mass.

If my memory deceives me not, Mr. Massee, in the same paper, divided the genus Calostoma into two groups, the so-called eastern group, growing in Asia and the adjacent islands, with globose spores, and the western group, the habitats of which are America and Australia, with elliptical spores. Now the Japanese species in question has its spores oblong-elliptical, which fact would seem to necessitate such a naming of the groups as eastern and western to be modified more or less.

KUMAGUSU MINAKATA.

Mount Nachi, Kii, Japan, June 5.

THE specimens of fungi from Japan belong to *Calostoma Ravenelii*, Mass., agreeing in every essential point with the type of that species preserved in the herbarium at Kew.

In the monograph referred to in the letter accompanying the specimens, the form of the spores was not made a basis of classification, but the fact was simply pointed out that eastern species possessed globose spores, whereas in all known western species the spores were elliptical.

The fact of a North American species occurring in Japan, while very interesting, will not cause surprise to botanists, considering the intimate relationship between the phanerogamic flora of the two countries.

GEO. MASSEE.

School Geometry Reform.

IN your issue of June 25, Mr. R. W. H. T. Hudson criticises the fact that, in my "Elementary Geometry," I give three meanings of the word angle, the third being what may be called the "sector of plane space" meaning.

He considers that, even if not wrong, it is undesirable in a school book. It seems to me that the one essential point which requires attention in introducing a new subject to boys and girls is to attach a clear, definite meaning to the terms employed, and that, if there be any terms such as this word "angle," of which many people have confused notions owing to the bringing together and blurring of two or three distinct meanings, then those meanings should be carefully dissected.

Mr. Hudson quotes with approval the French writers who, while stating that an angle is a simple undefinable idea, incidentally give "inclinaison mutuelle" as a synonym; personally, I am adverse to the word "inclination," it seems to mean a "leaning *towards* one another," whereas an angle is a "leaning *away* from one another," if it be a leaning at all. I have endeavoured to express this idea in my second meaning, the "wideness" of the opening between two radii drawn from a point.

That the space-sector meaning is implied in nineteenth century Euclids is indisputable, *e.g.* in iii. 20 we have "Case i., when the *centre is within* the angle"—how could the centre lie within a "mutual inclination" or within "an amount of turning"? Again, "a solid angle is . . . made by . . . plane angles . . . *meeting at one point*"—how can "mutual inclinations" meet? I doubt even if a "mutual inclination" is more capable of being bisected than is any other abstract quality, say, for example, gratitude.

Mr. Hudson speaks of the *axiom*, "whole is greater than its part": surely this is no axiom at all; it is a *definition*, whether of "a part" or of "greater than" I would not venture to say.

Whether my position be right or wrong, it is surely preferable to the attitude which makes geometry the "science of the undefinable."

I am grateful to your reviewer for the suggestion that angles should be quoted in decimals of a degree rather than to the nearest ten minutes, and will adopt the suggestion as soon as possible.

FRANK R. BARRELL.

University College, Bristol, July 6.

The Moon's Phases and Thunderstorms.

IN connection with the note in NATURE (July 9, p. 232), it is interesting to compare the results of Prof. W. H. Pickering with those obtained by Schiaparelli in 1868, from the discussion of observations made in Vigevano (north Italy) for thirty-eight years (1827–1864) by Dr. Siro Serafini.

"Sebbene i numeri della seconda colonna presentino delle grandi irregolarita nel loro andamento, sembra tuttavia indubitato, che nella prima metà della lunazione i temporali debbano in generale essere meno frequenti che nella seconda. Facendo la somma di 5 in 5 per veder meglio la legge di progressione, si vede che il minimum cade verso il 5° giorno della lunazione, il maximum verso il 24°. E la proporzione della frequenza minima alla massima è quella di 101 : 153, ciò è quasi esattamente di 2 : 3."

Translated into English, the quotation reads as follows:—"Although the figures of the second column show great irregularities in their proceeding, it seems nevertheless undoubted that in the first half of a lunation thunderstorms may be, generally speaking, less frequent than in the second. Adding 5 by 5 in order to see better the law of progression, one remarks that the *minimum* falls towards the 5th day of the lunation and the maximum towards the 24th. The ratio of the least frequency to the greatest is that of 101 : 153, or almost exactly of 2 : 3." (Clima di Vigevano: Milano Vallardi, 1868, p. 81.)

The conclusion is thus exactly the reverse of what Prof. W. H. Pickering has found.

OTTAVIO ZANOTTI BIANCO.

THE NEW MAMMOTH AT ST. PETERSBURG.

THE new mammoth just mounted for exhibition in the Zoological Museum at St. Petersburg, is a triumph of the taxidermist's art. The frozen skin has been cleaned, softened, and prepared. The skeleton, and as many of the surrounding soft tissues as possible, have been carefully removed from its interior and preserved separately. The animal has been actually stuffed like a modern quadruped, and placed in the attitude in which it originally died. The skin of the head and the ears are artificial, copied from the famous old specimen obtained a century ago by Adams. A model of the base of the proboscis has also been added. The skin of the trunk and limbs, however, is nearly complete, only embellished in parts by the addition of a little wool and hair from other specimens; and some deficiencies are covered by the surrounding mount, which represents the morass into which the animal slipped. The well-preserved tail is especially noteworthy, and bears a large tassel of long black hair at its tip. The animal is a young male of rather small size.

The hopelessly-struggling aspect of this mammoth is very striking, and reproduces exactly the attitude of the carcase as it lay buried in the Siberian tundra. In fact, the chief value of the specimen depends upon the circumstance that it was scientifically disinterred, photographed at various stages in the excavation, and carefully preserved by the best modern methods. Great credit is due to Dr. Otto Herz, the leader of the expedition organised by the St. Petersburg Imperial Academy of Sciences, who undertook the arduous task of securing the carcase and transporting it to the Russian capital. His are the only photographs hitherto obtained of a mammoth buried in the tundra, and they throw important new light on the question of the conditions under which these large quadrupeds were destroyed and entombed. Some of Dr. Herz's photographs have lately been presented by Dr. Salensky to the British Museum, and two of them are reproduced in the accompanying figures.

FIG. 1.—Front view of Mammoth in frozen earth on the banks of the Beresowka, Jakutsk, showing the bent fore limbs widely spread. From photograph by Dr. O. Herz.

The carcase in question was exposed by a landslip on the bank of the River Beresowka, an affluent of the Kolyma, in the Government of Jakutsk, in latitude 67° 32′ N. The head was entirely uncovered, so that the foxes and other carnivores ate its soft parts, while the inhabitants of a neighbouring village removed a tusk. The Governor of Jakutsk, however, succeeded in keeping the remainder of the specimen undisturbed until the arrival of the expedition from the Academy. It was buried partly in ice, partly in frozen sand and gravel, and there was a sufficient covering of earth to prevent its naturally thawing.

According to the general report published by Dr. Herz,[1] he began to excavate the specimen from the front. In this manner he soon discovered the two fore limbs spread widely apart, and sharply bent at the wrist, as shown in the first photograph (Fig. 1). Proceeding backwards on the left side, he unexpectedly met with the hind foot almost at once, and it gradually became evident that the hind limbs were completely turned forwards beneath the body, as shown in the second photograph (Fig. 2). Dr. Herz then removed the skull, and found the well-preserved tongue hanging out of the mandible. He also noticed that the mouth was filled with grass, which had been cropped, but not chewed and swallowed. Further examination of the carcase showed that the cavity of the chest was filled with clotted blood. It is therefore natural to conclude that the animal was entrapped by falling into a hole, and suddenly died from the bursting of a blood-vessel near the heart while making an effort to extricate itself. As shown by the recent researches

FIG. 2.—Left and partly posterior view of the same specimen, showing the bent left fore limb and the left hind limb turned forwards beneath the body. From photograph by Dr. O. Herz.

[1] "Berichte des Leiters der von der kaiserlichen Akademie der Wissenschaften zur Ausgrabung eines Mammuth-kadavers an die Kolyma-Beresowka ausgesandten Expedition" (St. Petersburg Academy of Sciences, 1902).

of Dr. Tolmatschow,[1] the ice surrounding the carcase was not that of a lake or river, but evidently formed from snow. It is thus quite likely that the mammoth was quietly browsing on grassland which formed the thin covering of a glacier, and fell into a crevasse which was obscured by the loose earth. On this subject, however, much more information may shortly be expected, when Mr. Ssewastianow publishes an account of the geological researches which he made in the neighbourhood of the Beresowka last summer.

The director of the Zoological Museum of St. Petersburg, Dr. W. Salensky, has not only arranged an admirable and unique exhibition of the newly-acquired mammoth, but has also devoted much time to a scientific investigation of the specimen. The results of his researches will be published by the Imperial Academy of Sciences in a series of memoirs, of which the first, dealing with the skeleton, has just appeared. In this work, he not only describes the parts of the new animal, but also refers to the rich collection of remains of the Siberian mammoth already in the museum under his direction. The first instalment, illustrated with twenty-five fine plates of bones and teeth, is unfortunately written only in the Russian language. We venture to express the hope that, when his work is completed, Dr. Salensky will make it more generally accessible by appending a copious abstract in one of the languages with which most naturalists are familiar.

A. S. W.

THE ETHNOLOGY OF THE MALAY PENINSULA.[2]

THE scientific results of the Skeat expedition of 1899 to Siam and the Malay Peninsula have not yet been published, but a secondary result of that expedition was the return of Mr. Nelson Annandale to the same district in 1901. Sir William Turner suggested to Mr. Annandale that he should obtain measurements of the people of the Siamese Malay States, and the Edinburgh University gave him a grant for that purpose from the Moray Fund. Mr. H. C. Robinson joined Mr. Annandale, and together they made a most successful expedition, the results of which are now beginning to appear with praiseworthy promptitude, a result that is rendered possible through private munificence in Liverpool. The association of this expedition with the University of Liverpool augurs well for the spirit of that young institution, and we hope tnat it may continue to foster field work in ethnology.

The present fasciculus contains a general account of the appearance and mode of life of the Semang and Sakai tribes of the Malay Peninsula, of the coast people of Trang, and of the Malays of Perak, and detailed studies of the external physical characteristics of these tribes, together with some valuable osteological observations. So far the authors have presented us with a considerable body of data which are at once available to students for comparative purposes, but they reserve comparisons and discussions until the final part. We look forward with great interest to the fulfilment of this promise, as there are several important ethnological problems connected with the region visited that students at home have no means of solving. When the full results of this expedition are before us, as well as those of the Skeat expedition (which we hope will not long be delayed), we shall be in a better position to reconstruct the anthropological history of a very important district, a knowledge of which is necessary before the ethnological problems of the Indonesian Archipelago can be unravelled.

A general sketch of the main results, from a racial point of view, will be found in the authors' paper in the current number of the *Journal* of the Anthropological Institute, but for the facts on which they are based the student must have recourse to the "Fasciculi Malayenses." Only part i. of this series has yet been published, and as no forecast is given of what is to be expected, one cannot say very much about the accounts of the social life of the jungle tribes, as subsequent parts may render the criticism void. It is safe to say that the physical anthropology is well done, and will prove of permanent value, to which the excellent illustrations of natives materially assist. The characteristic decoration, clothing, implements, habitations, and other details of the several tribes, which an intelligent traveller can readily observe, are carefully noted, and some curious engraved designs and patterns on dart cases, combs, and other objects are figured and partially described. There is an interesting chapter by Mr. Annandale on the beliefs and customs of the Patani fishermen. These Malays have various animal cults, but they certainly do not present any features of true clan totemism. This is followed by the first part of an essay on religion and magic among the Malays of the

FIG. 1.—Semang (Semán) shelter, with kitchen (occupied by married couple); Grit, Upper Perak.

[1] "Bodeneis vom Fluss Beresowka (Nord-ost Sibiriens)," (*Verhandl. k. russ. min. Ges.*, vol. xl. pp. 415–452, pls. v–viii, 1903.)

[2] "Fasciculi Malayenses: Anthropology." Part i. (London: Longmans, Green and Co., 1903.) Price 15*s*. net.

Patani States, in which souls and ghosts are dealt with; a consideration of ghosts and spirits unconnected with material bodies will be published in another part.

The work is admirably printed, and the illustrations are excellent. This first part reflects great credit on the University Press of Liverpool.

ELECTROCHEMISTRY IN AMERICA.

THE third meeting of the American Electrochemical Society took place in New York on April 18. Three meetings may seem rather a small number for a society which has been in existence for more than eighteen months, but the society, which has members from all parts of the United States, only meets once in six months, and the meetings assume the form of a congress, which lasts several days. This style of meeting, which might be compared to the annual meeting of the Society of Chemical Industry, in which members from all parts of the country meet together each year in a different town, partly for work and partly for social intercourse, has certain obvious advantages, in that country as well as town members are able to attend; there is, however, one disadvantage, and that is that papers are only published once in six months. The transactions of the society are also only published once in six months, hence they contain the concentration of six months' work.

The presidential address of Dr. Joseph W. Richards, an abridgment of which is printed below, contains several points of considerable interest. One thing which will strike British electrochemists is that although the Americans have made great progress in the industrial applications of electrochemistry, yet they have to admit that they owe their present position in a large measure to foreign trained electrochemists. Dr. Richards mourns that they are vastly behind the Germans in the number of their chairs and laboratories of electrochemistry. How much more, then, should we in this country mourn—*we have not a single chair devoted to the teaching of electrochemistry*, and there are only two or three laboratories in the whole kingdom.

It is often said that, having very little water power in this country, we can never expect to compete industrially with other countries in electrochemical processes. Dr. Richards remarks that although all countries have not Niagaras, they have gas-engines, and he points out some of the sources of gas supply. Finally his remarks upon the value of literature, *good, sound literature*, are worth consideration. Where is the British electrochemical literature to be found?

To live is to progress, and to progress is to live. A science which does not progress petrifies. The science of electrochemistry has progressed so magnificently in the last decade that a mere catalogue of its achievements would be a monumental compilation. Abler and better-informed pens than mine have given to us recently, in presidential addresses and in careful reviews, the detailed history of this progress. I do not intend to attempt that task anew this evening; my theme is an analysis of the *conditions which make for progress*, and which I hope to make clear in all their bearings on electrochemical science.

I place discovery of new facts in electrochemical science as the corner-stone of progress in our science. Given a freshly-flowing current of new electrochemical facts, and all the other elements of progress have a chance to exist. No less certain than this is the location of the birthplace and the identity of the sponsors of these newly-born facts. The birthplaces are chemical, electrical and physical laboratories; the sponsors are the investigators, the searchers after truth—the professors, students, employees, private investigators, and all who with the insatiable thirst for more knowledge are pushing back the thick curtain of the unknown which hems us in so closely on every side. The elect among these workers, the highly-favoured few, are the professors of electrochemistry provided with well-equipped electrochemical laboratories. They are in the position to do or to direct the most valuable investigations, and are also under the moral obligation to publish freely to the world all that they discover. The giants of the electrochemical fraternity are in this class: Davy, Faraday, Bunsen, Arrhenius, van 't Hoff, Ostwald, Nernst, Moissan. The labours of such workers, given to the world in their publications, form the *body* of electrochemical science, and their thoughts—its *soul*. Such are the heroes of science; men who work for the work's sake, who sacrifice time, money, and often health, to increase the boundaries of our knowledge, and then keep nothing back.

The German-speaking countries count up alone at their universities and technical schools fifteen chairs of electrochemistry and twelve electrochemical laboratories. These, we all know it, have been the source of the greater part of the advance of electrochemical science in the last ten years. The whole industrial electrochemical world is debtor to the European electrochemical laboratories and their workers, and how can that debt be requited? Surely not by selfishly using all the facts and holding fast all the material benefits. Not only common gratitude but also self-interest unite in recommending to the captains of electrochemical industry that more such laboratories be built and more such chairs endowed; money thus spent will be seed which will return many fold its value to the industry. America has boasted that it is "The Electrochemical Centre of the World." It may be so, in the development of electrochemical industries, in the amount of power used and material products turned out; but is it not a fair question to ask "Where are the professors of electrochemistry at our universities and how many electrochemical laboratories are at their command?" Are we not out of comparison with Germany in that respect—but I trust not hopelessly so? Our present flourishing condition industrially is largely due to our foreign-trained electrochemists and our imported literature. Shall we not, through shame at contributing so little ourselves to that literature, soon begin to establish chairs of electrochemistry and build well-equipped laboratories to go with them? Then our boast might begin to be more than the empty boast of a successful money-maker; then we may begin to be an *illuminating* centre radiating knowledge to the rest of the world.

In place of professors and professional laboratories, however, America is blessed with another class of investigators who are no less industrious in acquiring facts, and to whom a large part of our commercial success is directly ascribable; I refer to the small army of patient investigators in the laboratories of our industrial plants, who are searching over ground not yet explored and accumulating facts of value in their special industrial lines. The expense of such work is borne by the corporation for which they labour, and the work itself is in reality an investment made in the hope of yielding financial reward.

By means of facts, correlating, discussing and deducing therefrom, we arrive at a knowledge of the laws of science, the rules governing its various phenomena and according to which its manifestations invariably proceed. Such deductions are the goal of pure science; they contain no element of speculation, hypothesis or theory, and represent man's deepest insight into the phenomena of nature.

The indefatigable Faraday discovered our first fundamental laws. Ohm and Joule added to them, and numerous later investigators have contributed, but we must not make the mistake of thinking that there remains very little more in the nature of generalisations to be discovered; we could not make a greater mistake. If facts are being discovered, the recognition of unforeseen generalisations and the establishing of new laws are bound to follow, and thus the science reaches its highest consummation.

Such discoveries are usually the privileges and the perquisites of the experimenter and investigator, if so be that he is likewise a thinker. He gets the facts at first hand, and has the first chance to deduce new laws. The electro-

chemist not blessed with laboratory facilities has, however, free entrance to this field. He may be only a student, a looker-on at what others are doing, a reader of the newly-discovered and recorded facts, but if he is at the same time a thinker, a compiler, an analyst with the power of collating, dissecting and deducing, he may in the seclusion of his study discover laws which escape the observation of others less studious, and thus render a service of the highest value to the science.

As soon as facts accumulate and laws are discerned, the man of science inevitably begins to reflect on the why and the wherefore. He commences to search for relations, to imagine connections and dependencies, and to make pictures of the mechanism of the phenomena. It was thus that Dalton imagined the atomic theory to account for the fact of chemical combination in simple multiple proportions, that Arrhenius hit upon the dissociation theory to account for the increase of molecular conductivity with increasing dilution, that Nernst worked out the solution-pressure theory to explain the generation of current in the galvanic cell. Thus there are theories and theories, some poor, some good, and some almost perfect in their applicability, since, *granting their premises*, they give an explanation satisfactory to the mind of all observed phenomena.

Such theories are not only allowable, but necessary. We must have them, much as an artisan must have a working drawing of the machine he will construct; the drawing is but paper and ink, which never moves or works, but it guides the workman in putting his ideas into realities. So theories help us to handle mental conceptions as if they were concrete things, and thus to imagine and discover relations and generalisations which would otherwise be beyond our mental grasp.

The danger to the development of a science comes when a theory, by being believed too implicitly and by not being open to constant revision, becomes a strait-jacket for the growing science. Like a "creed outworn," it stifles criticism, warps the judgment, engenders blindness and bias in its adherents and undue hostility and acrimony in its opposers. We should be slow in revising our theories, or in discrediting a theory which has done us good service in its day, just as we are conservative in correcting our "confessions of faith" or indulgent and sympathetic with the weaknesses of a faithful old servant; but, after all, when a theory has come to be considered so firmly fixed as to be above criticism, or so certainly true as to be above the possibility of revision, or so well-established as to thunder its excommunications on those who dare to think or believe otherwise—such a theory had better be placed at once in the museum of scientific petrifactions, where it properly belongs, and where it can do no further harm.

If science is progressing, theories must progress too; they will be outgrown, much light will give way to more light, imperfect pictures of phenomena founded on crude assumptions must be replaced by better pictures corresponding more accurately to the newer and the larger truth, and then progress begins anew.

All theories have been of some use in their day; they have helped men to grasp concretely evanescent immaterial phenomena, they have very often been splendid guides to further experiment and new discoveries, they have at times been so helpful that many have mistakenly thought them infallible, and lastly, they have been stepping-stones to better theories. One great hindrance to scientific progress is the common human weakness of becoming partisans of a theory. Who is not familiar with the well-meaning theoriser whose mental vision is so biased that he refuses or is incompetent to give a fair reception to new facts and theories; or who has not met the egotistical speculator who experiments and makes researches not to discover truth, but to prove his pet theory? Thus the warmest friends of a theory are often its worst enemies, and by their blind partisanship lay obstacles in the path of scientific progress instead of being the leaders which they might be.

To make a specific application of these remarks, who has not felt that the most effective blows dealt the present theory of electrolytic dissociation have come from the excessive zeal of its warmest adherents? There are scientific zealots as well as religious bigots, and the one does as much harm to the progress of true science as the other does to the development of pure religion.

The fundamental conceptions of any and every theory must always be open to correction and revision, and thus progress will be rendered easy. If new facts appear which contradict our theories, let us welcome them, like loyal lovers of the truth should. The theory of electrolytic dissociation is being saved by being modified and revised, it is being transformed into a more perfect mirror of the truth as we now conceive it, and thus only is it retaining its usefulness and aiding in scientific progress.

Power alone is apt to be regarded as the first desideratum for the success of electrochemical processes, but knowledge, thinking power and industry are more primary factors. Given these, crude materials to work with will be found on every hand, and power sufficient will be created if it is not to be found.

A few words, however, about this question of the necessary cheap power. This item in manufacturing cost is of variable importance in electrochemical processes; in some it may form three-quarters of the total cost of the process, in others perhaps only one-quarter. The former are frequently compelled to move to the cheapest power, in order to exist at all, while such as the latter may take into account many other considerations, and find it cheaper for them to locate at more expensive powers. Niagara Falls is the most accessible of our great water powers, and has therefore drawn into its fold the majority of our electrochemical industries. But another source of surplus power is distributed over a large part of our country, in a condition at present as undeveloped as was Niagara power when Columbus touched our shores. I refer to the surplus power from blast-furnaces, obtainable by using gas-engines. Every blast-furnace burns its gases to heat its blast and to raise steam for its power. The two-thirds of its gases used for the latter purpose generate just about the power needed for the blowing-engines, pumps, hoists, &c., an amount equal on an average to 2500 horse-power for a furnace making 500 tons of iron per day. If the gas thus used was used in gas-engines, there would be an average surplus power, over and above all the requirements of the furnace itself, of 10,000 horse-power. The gas-engine plant needed to produce this power does not cost more than 50 dollars per horse-power investment, which compares favourably with the cost of developing water-powers, which vary from 25 dollars to 100 dollars per horse-power. It is thus deducible that there are scattered over the United States, in some of our most flourishing industrial centres, undeveloped powers which aggregate more than 1,000,000 horse-power, which can be developed at no more cost than the average water-power, can be generated just at the spots where they can be most favourably utilised, and without any more drain on our natural resources than the harnessing of a new water-power—for not a pound of coal more would have to be burnt than is used at present.

Other possible sources of power are the waste surplus gases from by-product coking ovens, and the utilisation of gas-producers, using cheap, almost waste, coal, in connection with gas-engines. Power therefore is available in immense quantities in places and in countries not blessed with Niagaras in their midst, and the industrial development of such sources will be one of the most marked industrial movements of the next ten years.

And now, let us inquire, how is this increasing development of power and its increasing application to industrial purposes best promoted by the electrochemists themselves. Undoubtedly, it is by the intimate and cordial cooperation of theoretical with practical electrochemists. This is attained by many agencies, but the most potent are research companies and our Electrochemical Society.

Such organisations as research companies, formed explicitly to combine research with practical application, are novelties in the industrial world which have originated with, and are almost peculiar to, electrochemistry. They invent, investigate and develop electrochemical process, and furnish facilities to would-be experimenters whose ideas might otherwise remain still-born. Such companies deserve the hearty support of all electrochemists, for they are injecting new life into the industry. May we have more such, scattered all over our land to nurse and develop quickly into active being the many electrochemical processes which *are to be*.

The factors which promote increasing applications of

electrochemistry are therefore cheap and accessible power, experimentation on a semi-industrial scale, men with heads full of ideas and inventiveness in applying them to the industrial needs of the country, more research companies and a further cultivation of the beneficent results of our society meetings.

By thus doing, cheap raw materials will be converted by the electrochemist into valuable products with constantly increasing ease and constantly decreasing cost, and thus electrochemistry will achieve its great *raison d'être* by increasingly ministering to the needs, the comforts and the pleasures of life, and thus it will become an increasingly important factor in social progress.

No modern science can progress if it adopts the mediæval practice of the alchemists, and carefully guards its wisdom for the exclusive use of the initiated. Widespread dissemination of the literature of our science, not only among our own fraternity, but among educated people in general, and even down to the rising generation of expectant men of science, is as necessary to our progress as is the recruiting of the human family to the preservation of the race.

The literature of our science consists of transactions, journals, treatises, monographs and text-books. Without these, and without the constant extension, improvement and dissemination of the same, our science would soon be dead indeed.

The transactions of our societies are the standing record of papers and discussions presented at our meetings. The contents represent the labours of many heads and hands, and the opinions of many minds. As such, they form a permanent record of the latest advances and the best thought in electrochemical lines. They are the reservoirs of information from which the other literature of the science, such as treatises and monographs, is largely compiled. They are of particular value to people who cannot personally attend the meetings which they report. Their value is augmented by being quickly printed and distributed, and the publication committees having that task in their charge should receive the cooperation of all authors in their efforts to prevent the transactions from becoming ancient history before they are issued. We may be pardoned referring with a little pride to the fact that the report of our Niagara meeting was distributed seven weeks from the close of the meeting, and that 25 per cent. of the papers presented at this, our most notable New York meeting, were in print before the meeting began.

The increasing membership of our societies, and the placing of such transactions in scientific and public libraries, are potent means towards interesting and instructing the world in electrochemistry, and recruiting the army of electrochemical workers.

Our text-books, intended to give beginners their first ideas of electrochemistry, should be most carefully written. Nothing sticks so permanently in the mind as a correct idea taken in youth from a good text-book—except an incorrect idea taken from a bad one, and I think that the latter often sticks the hardest. It used to be remarked that every professor elected to a chair of mineralogy in Europe felt himself expected to write a treatise on crystallography—and he generally wrote it; it is, of course, an exaggeration to say that every privat-docent elected to lecture on electrochemistry writes a text-book on the elements of the science, but it is an exaggeration with a grain of truth in it. There are entirely too many imperfect or partisan or downright execrable text-books of this kind; one good one, written by a master, is worth more than all of these poor ones put together. Electrochemistry should also be better presented in the elementary text-books of chemistry and electricity. The interrelation of these subjects is so intimate that the fundamentals of either necessarily include some of the fundamentals of the other, and beginners are wonderfully apt at comprehending the essential fundamental facts if they are skilfully presented. I recall to mind a very complete modern text-book of inorganic chemistry, written by a splendidly-informed chemist, in which the electrochemical part was turned over to an assistant, and, as a consequence, abounds in misstatements. We cannot afford to have our students started wrongly, and it is therefore of the highest importance that our text-books, while being as brief as is necessary, should be as accurate as is possible.

NOTES.

THE monument which was unveiled last month at Bonn, in honour of Prof. Kekulé, stands away from the city and just in front of the building of the chemical laboratories of the University of Bonn, the place in which Kekulé laboured and taught for so many years and with such pronounced and conspicuous success. The statue stands on a granite pedestal, and is life-size and of bronze. On each side of the sculptured figure of Kekulé is a sphynx. The character of the man, simple and unpretentious, yet convincing, is well brought out, and some of his greatest scientific achievements are clearly represented in relief on the pedestal. At the unveiling ceremony many universities and scientific bodies, foreign as well as German, were represented, and so also were numerous firms engaged in the chemical industry.

THE third International Mathematical Congress has been arranged to take place in Heidelberg on August 8–13 of next year. The congress will be divided into six sections, dealing respectively with arithmetic and algebra, analysis, geometry, applied mathematics, history of mathematics, and pædagogics. In addition to the business and sectional meetings, there will be conversaziones, a banquet, and an excursion up the Neckar, and illumination of the Castle. The year 1904 is the centenary of the birth of C. G. J. Jacobi, and the occasion will be celebrated in connection with the congress by the publication of a memorial volume on Jacobi under the authorship of Prof. Königsberger. The secretarial work of the congress is in the hands of Prof. A. Krazer, of Carlsruhe.

THE Anthropological Institute announces that Prof. Karl Pearson, F.R.S., has accepted its invitation to deliver the annual Huxley memorial lecture this year. The lecture will be delivered on Friday, October 16, at 8.30 p.m., in the lecture theatre of Burlington House. Prof. Pearson has chosen for his subject, "On the Inheritance in Man of Moral and Mental Characters, and its Relation to the Inheritance of Physical Characters."

A REUTER message from Strassburg states that the second International Seismological Conference, the object of which is to found an association for the study of seismological phenomena in countries interested in the question, was opened there on July 24. Twenty States were represented. The Statthalter of Alsace-Lorraine, who is patron of the conference, welcomed the delegates in the name of the German Empire.

THE Government has appointed Captain Harry Mackay, a Dundee whaling master, to the command of the *Discovery* relief expedition. The relief ship *Terra Nova* will be manned by an entirely civilian crew, chiefly whalemen. The ship is expected to be ready for sea in about a month, and it has been decided, instead of making a long passage round the Cape, to proceed by the Suez Canal. Arrangements will be made to ensure that, after passing Gibraltar, the *Terra Nova* will be towed by fast vessels of the Royal Navy attached to the Mediterranean and East India stations. The relief ship will proceed to Hobart, where she will be joined by the *Morning*.

THE bust of the late Sir William Flower, prepared for the Flower Memorial Committee by Mr. Thomas Brock, was formally presented to the trustees of the British Museum, at the Natural History Museum, on Saturday last. Dr. P. L. Sclater gave an address in the name of, and on behalf of, the 185 subscribers to the fund.

THE Mackinnon research studentships of the Royal Society have been awarded for the year 1903–4 to Mr. F. Horton for physical research, and to Miss A. L. Embleton for biological research.

THE French Association for the Advancement of Science will hold its thirty-second annual meeting this year at Angers from August 4 to 11, under the presidency of M. Levasseur, Administrator of the Collége de France.

GOVERNOR LANHAM, of Texas, has, *Science* announces, issued a proclamation offering a reward of 10,000*l.* from the State to any person who discovers a practical method for eradicating the cotton boll weevil.

AT an extraordinary general meeting of the members of the Jenner Institute of Preventive Medicine on July 22, a resolution to alter the name of the institute to "The Lister Institute of Preventive Medicine," proposed by Sir Henry Roscoe, seconded by Sir Joseph Fayrer, and supported by Prof. W. J. Simpson, was unanimously adopted. A second meeting will be held on August 7, when the resolution will be submitted for confirmation.

THE council of the Society of Arts attended at Marlborough House on Monday, when the Prince of Wales, as president of the society, presented the society's Albert medal to Sir Charles A. Hartley, "in recognition of his services, extending over forty years, as engineer to the International Commission of the Danube, which have resulted in the opening up of the navigation of that river to the ships of all nations."

AN outline programme has been issued for the autumn meeting of the Iron and Steel Institute to be held at Barrow-in-Furness on September 1–4. The president, Mr. Andrew Carnegie, will deliver a short address, and the papers down for reading include the following:—Alloys of iron and tungsten, Mr. R. A. Hadfield; the restoration of dangerously crystalline steel by heat treatment, Mr. J. E. Stead and Mr. A. Windsor Richards; the influence of silicon on iron, Mr. Thomas Baker; the diffusion of sulphides through steel, Prof. E. D. Campbell; the heat treatment of steel, Mr. W. Campbell; the diseases of steel, Mr. C. H. Ridsdale; carbon in iron, Prof. A. Stansfield.

Science announces that the Bufalini prize of the University of Florence will be awarded at the end of October, 1904. This prize is of the value of 240*l.*, and is awarded once every twenty years. The subject is the value of the experimental method in opposition to the speculative method of scientific research.

AN international exhibition is to be opened at Arras, in the north of France, on May 1, 1904, and remain open until the following October. It is under the patronage of the President of the French Republic, the honorary president of the automobile section being the King of the Belgians. Industrial chemistry is dealt with in one of the classes, and another is devoted to alcohol and its production.

IN reply to a question on the position of wireless telegraphy in the Navy, Mr. Arnold-Forster has stated that all battleships, and a very large number of cruisers, are fitted either with the Marconi system of wireless telegraphy or with modifications of that system. The present average expenditure upon wireless telegraphy is about 20,000*l.* per annum, a considerable portion of this amount being paid to the Marconi Company. An agreement with the Marconi Company is now being concluded, and the use of wireless telegraphy throughout the service will be greatly extended in the future.

SOME additional particulars of the International Congress of Science and Arts to be held at St. Louis next year were published in Monday's *Times*. A body of men of learning from all parts of the world will assemble at St. Louis in connection with the congress, and it is hoped their deliberations will stimulate thought, promote science, and thus form a permanent contribution to the world's progress. An administrative board has been entrusted with the arrangements in connection with this new departure, and Prof. Nicholas Murray Butler, of Columbia University, is at the head of it. The main features of a plan proposed by Prof. Münsterberg, of Harvard University, for the conduct of the proceedings of this section have been adopted.

REUTER reports that on July 22, after a period of explosions, there was a flow of lava from Mount Vesuvius.

THE Museum of Practical Geology, Jermyn Street, will be closed to the general public during the painting of the interior from August 1. The business of the Geological Survey will, however, be carried on as usual, and visitors requiring special information will be admitted to the Museum.

THE Rev. G. W. Rawlings, of Ōsaka, Japan, sends us an interesting example of the pertinacity and strength of Japanese sparrows. A pair of sparrows he found flying about his bedroom one morning had begun to build in a corner of the room, and though the beginnings of the nest were cleared away each morning, the sparrows repeated their attempt three or four successive days. A clothes-brush placed in the corner to keep the birds away was found to have been moved by the sparrows, though it was six inches long and two inches wide.

MR. F. W. BRANSON, of Leeds, sends us an account of some experiments made by him with a mixture of radium and barium chlorides in a dry and in a moist state. When the substance was moistened with water and stirred, its radio-activity was only slightly reduced, though the luminosity instantly disappeared, but it was restored by drying for fifteen minutes at 150° C. When placed in benzene the dried salt retained its phosphorescence. Benzene, however, appeared to diminish somewhat the emission of light rays. Exposure of the dried salt for a few hours to a moist atmosphere caused a total cessation of phosphorescence, but not in a dry atmosphere. No action could be observed on a photographic plate exposed to the radiations from the moistened salt for thirty seconds, whereas the dry salt gave a full image in the same time. A much longer exposure of the moist salt gave a faint impression, about equal in amount to that produced by an equivalent amount of the dried salt, when the latter was covered with a thin paper, opaque to light rays.

AT the beginning of this year Mr. A. E. Shipley directed attention in these columns (vol. lxvii. p. 205) to the widely spread belief that a basil plant (*Ocimum viride*) provided a means of protection against mosquitoes. Observations made by Captain H. D. Larymore at Lokoja, Northern Nigeria, seemed to show that the belief was well founded, but Mr. Shipley pointed out that further experiments were needed upon the subject. The article was reprinted in the *British Medical Journal*, and was referred to by many other periodicals; and in consequence requests for seeds of the plant were received at the Royal Gardens, Kew, from many parts of the world. Sir William Thiselton-Dyer has, however, sent to the *Times* of July 27 a report of experiments made on the basil plant in relation to its effect on mosquitoes by Dr. W. T. Prout, at Freetown, Sierra Leone, and he remarks that it "appears to dispose conclusively of the plant's possessing any real protective value." The conclusions arrived at by Dr. Prout as the result of his experi-

ments are:—(1) Growing plants have little or no effect in driving away mosquitoes, and are not to be relied on as a substitute for the mosquito net. (2) Fresh basil leaves have no prejudicial effect on mosquitoes when placed in close contact with them. (3) The fumes of burnt basil leaves have a stupefying, and eventually a destructive, effect on mosquitoes, but to obtain this action a degree of saturation of the air is necessary which renders it impossible for the individual to remain in the room. It is probable, however, that cones made of powdered basil would, when burnt, have the effect of driving mosquitoes away, and to this extent might be found useful.

A REPORT has been issued by the London County Council upon the manufacture of aërated waters in London. It is recommended that, in view of the large consumption of aërated waters, the premises upon which they are manufactured should be registered and periodically inspected in order to ensure a proper standard as regards sanitary conditions.

WE recently noted in these columns the outbreak of ankylostomiasis (infection with a parasitic worm) which has occurred in the Dalcoath mine, Cornwall, reported upon by Drs. Haldane and Boycott. A report has now been issued by the Home Office on an outbreak of the same disease in the Westphalian colliery district in Germany. A case has also been met with in Scotland by Dr. Stockman. In all probability, therefore, this disease is more widespread than was formerly supposed.

DR. TIMBRELL BULSTRODE's report upon alleged oyster-borne illness following the mayoral banquets at Winchester and at Southampton has been issued by the medical officer of the Local Government Board. Dr. Bulstrode summarises the facts as follows. Two mayoral banquets were given on the same day in two towns. After both banquets a certain percentage of guests, all of whom had partaken of oysters, were attacked with illness of analogous nature, in some cases with definite enteric fever, in others with gastro-intestinal disturbance only. The oysters supplied to both banquets were from the same source (Emsworth), and the oysters from this source were at the same time and in other places proving themselves competent causes of enteric fever.

IT is reported that Prof. Kossel, of the Imperial Department of Health, Berlin, supports Prof. Koch's view of the non-transmissibility of bovine tuberculosis to man. He stated at a recent meeting of the Berlin Medical Society that out of all the experiments conducted by the Imperial Board of Health, in two cases only had human tubercle bacilli affected the experimental animals. Prof. Orth, the successor to Virchow in the University of Berlin, on the other hand, states that in his own experiments 10 per cent. of the animals were infected with the tubercle bacillus of human origin. At the recent congress of the Royal Institute of Public Health, Prof. Young, who has collaborated with Prof. Hamilton, of Aberdeen, said that their experiments upon twenty calves left no doubt of the communicability of human tuberculosis to bovines, and Drs. Dean and Todd have proved the same point as regards pigs.

IN a paper entitled "Luftelektrizität und Sonnemtrablung" (Leipzig), Dr. H. Rudolph develops a theory of the origin of atmospheric electricity. We do not think his theory is likely to meet with general acceptance; the reasoning by which he arrives at the laws on which his mathematical investigation is based is, to say the least, by no means convincing. In an appendix the author mentions a method which he has invented for employing a captive balloon to collect from the upper atmosphere the large amount of electrical energy which he believes to be now running to waste, and he complains that the public have not given his scheme the support that it deserves.

THE "spinthariscope" devised by Sir William Crookes to show the scintillations which are produced on a blende screen when a piece of radium nitrate is brought near it, is now made by several scientific instrument makers. Mr. A. C. Cossor, of 54 Farringdon Road, has sent us one of these instruments, which consists of a short brass tube having at one end a blende screen with a speck of radium salt about a millimetre in front of it, and at the other end a simple convex lens. The instrument is very satisfactory, and shows the scintillations wonderfully well; it provides a convenient means of observing the action of radium, and can be recommended as a waistcoat-pocket instrument of scientific value.

WE have received a copy of the observations made at the Batavia Observatory during the year 1901; it contains hourly meteorological values and seismometric records, but the magnetometer was out of action during the year, owing to its removal to Buitenzorg. We are glad to see that the Netherlands Government propose to undertake a magnetic survey of the East Indian Archipelago, extending from longitude 95° to 140°; this will be a valuable addition to the magnetic survey of British India. An appendix to the volume contains a discussion of the anemometric observations for the ten years 1891–1900. This laborious investigation shows that calms largely predominate, especially during the westerly monsoon, from December to April. The direction of the wind during this period is chiefly from the north-western quadrant. From April to November, northerly and north-easterly winds predominate by a large percentage. The greatest horizontal displacement of the air occurs between August and October, during which time easterly trade-winds largely prevail. Another appendix contains valuable electrical and meteorological observations made during the total eclipse of the sun on May 18, 1901, at various stations.

THE *Quarterly Journal* of the Royal Meteorological Society (No. 127, July) contains an important and interesting paper on the prevalence of gales on the coasts of the British Islands during the thirty years 1871–1900, based on the data collected annually in the Meteorological Office for the purpose of testing the accuracy of storm warnings issued. We can only refer here to some of the general results:—the mean annual number of gales experienced on the west coasts is 29·6; of the total number 82 per cent. occur in the winter half-year; on the north coasts the mean number is 25·7, with a percentage of 84 in winter; on the south coasts, mean 19·1, winter percentage 80; on the east coasts, mean 15·6, with 84 per cent. in the winter half year. As regards direction, the mean results show that on the west coasts about 68 per cent. of the gales blew from the Atlantic, or equatorial directions, and about 26 per cent. from the Arctic, or polar directions; on the north coasts about 66 per cent. blew from equatorial, and 30 per cent. from polar quarters; on the south coasts the numbers were respectively 73 and 25 per cent; the results for the east coasts show that less than 53 per cent. blew from equatorial directions, and more than 44 per cent. from polar quarters. The prevalence and direction of gales in each division are plainly illustrated by wind-roses.

AN account of the flora of the north island of Nova Zembla appears in the *Bulletin du jardin impérial botanique* of St. Petersburg. The author, Mr. Palibin, observes that the flowering plants are most closely allied to those found in the Arctic regions of Asiatic Russia, but the algal flora resembles rather that of Spitsbergen.

A SECOND paper by Prof. Vines is published in the *Annals of Botany*, and gives an account of further investigations into the action of proteid-dissolving ferments in plants. Certain divergences appear to exist between the observations of the author and other experimenters; these are traced to the use of different antiseptics, so that it becomes necessary to try several antiseptic substances before formulating any conclusions as to the digestive power of the ferments under consideration.

THE formation of the first tropical experiment station in the British Empire in Ceylon, has already been referred to in these columns. Apart from agricultural experiments and the cultivation of economic products, questions of pure scientific interest will doubtless receive attention. In his report, Mr. Wright, the controller of the station, announces that experimental plots have already been laid out to determine how far the cultivated varieties of cacao plants bearing pure purple or pure white seeds will breed true. Should this be the case, the results produced by crossing will give valuable evidence for testing the Mendelian laws.

AMONG other articles, the *Transactions* of the Manchester Microscopical Society for 1902 contain some interesting observations by Mr. J. Barnes on the microscopic structure of the mountain limestone of Derbyshire. In the first place, it is recorded that the rock contains large numbers of very minute but perfectly formed quartz-crystals, frequently formed round a jaspideous nucleus. Of special interest is the description of a mottled phase of the mountain limestone, in which the dark portions have been produced by the carbonaceous matter contained in foraminifera, with which the rock is crowded.

THE Geological Survey has issued a memoir on the geology of the country around Reading, by the late Mr. J. H. Blake, edited by Mr. H. W. Monckton. The district is a part of the London Basin, with a foundation of Chalk, overlain by Reading Beds, London Clay, Bagshot and Bracklesham Beds, with extensive coverings of plateau and valley drifts. The Reading Beds are of special interest, and many detailed sections of the strata are given, with an analysis, by Dr. W. Pollard, of the mottled clay which is so largely worked for brick- and tile-making. There are also figures of some of the plant-remains which are found in the strata. A list of fossils from the basement-bed of the London Clay is likewise given. Mr. Monckton has contributed many notes relating to the superficial deposits.

SOME interesting facts referring to the cultivation and economic uses of the potato in Germany were recently stated by the American Consul-General in Berlin in connection with a technical exhibition there. In 1901, for every 10,000 inhabitants 160 acres were planted with potatoes, against 98 acres in France, 31 in Great Britain and Ireland, and 34·8 in the United States. The sandy plains of northern and central Germany are well adapted by nature to the cultivation, and elaborate experiments in scientific fertilising and cultivation have increased the production per acre by about 38 per cent. in the last ten years. The result has been that the crop reached the danger point of over-production in 1901, and accordingly there was in that year an enormous increase in potato alcohol, and the market was glutted with raw spirit. In February, 1902, there was an exhibition in Berlin to illustrate and promote the use of denaturised alcohol for technical and industrial purposes, and it has been repeated this year. Besides alcohol, the technical products of the potato are starch, starch syrup, potato flour, dextrin, and starch sugar. The production of these during the last ten years has increased rapidly, as has the export also. Last year the exports of potato flour and starch reached 45,970 tons, or more than double those of 1900, while the export of dextrin was 14,047 tons. The United Kingdom is the largest purchaser of German potato starch, the imports last year being 23,827 tons. The Consul-General adds that the law of 1887 regulating the production and use of untaxed alcohol for technical purposes was one of the wisest and most far-seeing of enactments, for Germany has profited largely by the stimulus thereby given to the cultivation of the potato and to the employment of cheap spirit in the chemistry and the industrial arts.

WE have received a copy of an article published in the Natural History and Scholastic *Abhandlungen* of Leipzig, by Mr. F. Mühlberg, on the object and extent of the instruction in natural science given in the higher middle-schools.

WE have received two further instalments of Messrs. Jordan and Fowler's valuable reviews of Japanese fishes, in course of publication in the *Proceedings* of the U.S. Museum, the one being devoted to the carp group, or cyprinoids, and the other to the cat-fishes, or siluroids. In both groups several new forms are described, some of which have, however, been already referred to in preliminary notices. A new genus of cat-fish receives the name of Fluvidraco, and apparently includes the well-known "yellow dragon" of the rivers of China. In another fasciculus of the same publication Mr. T. Gill discusses the affinities of the opah, or king-fish, and finds that he is not able to accept in their entirety the views on this subject recently published by Mr. G. A. Boulenger. He has some interesting observations on the origin of the name "opah," which appears to have been imported from the west coast of Africa, but does not seem to be the proper native title of the fish to which it is now applied.

THREE other papers from the *Proceedings* of the U.S. Museum are also to hand. In one of these Mr. D. W. Prentiss describes as new an imperfect mink skull from the shell-mounds of Maine. In the second Mr. A. N. Caudell discusses the orthopterous insects of various States, with descriptions of new species; and in the third Mr. J. E. Benedict revises the crustaceans of the genus Lepidopa.

AN issue of the *Circulars and Agricultural Journal* of the Royal Botanic Gardens at Ceylon contains an account, by Mr. E. E. Green, of a recent abnormal and remarkable increase in one district of the numbers of the so-called lobster-caterpillar (*Stauropus alternus*), which affects tea-plants. Until quite recently this caterpillar was so uncommon that good specimens were regarded as prizes by collectors; but latterly it has made its appearance in enormous numbers on certain plantations in the Kalutara district, where it has become a perfect "tea-pest." The reason for this sudden increase has not been ascertained.

ALL that Mr. E. Thompson-Seton writes with regard to the habits and ways of animals is well worth reading, and we are therefore glad to welcome an article from his pen in the Smithsonian Report for 1901 entitled "The National Zoo at Washington, a Study of its Animals in Relation to their Natural Environment." The author describes in some detail the history of the formation of this great and important undertaking, and the prime object which the founders had before them, namely, the preservation of as many of the larger North American animals as possible under conditions assimilating, so far as practicable, to their natural surroundings. In the case of many species, such as the wapiti, the bison, and the pronghorn, the experiment

has, up to the present, been a decided success. There are, however, a number of mammals, inclusive of the bighorn sheep, the true blacktail deer, the mule-deer, the moose, the white goat, and the grizzly bear—all more or less in danger of extermination—which have not yet been established in refuges of their own. This, it is said, is largely due to lack of funds; and the author points out that if the Alaskan brown bear—the largest living member of its kind—be not soon established in the gardens, it will be too late. Many interesting traits in the habits of American mammals are recorded, notably the fact that the prongbuck expands the hairs of its white rump-patch in a disc-like manner when alarmed, after the fashion of the Japanese and Peking deer, the white patch, when thus expanded, forming a conspicuous "recognition mark."

MESSRS. WATTS AND CO. have issued for the Rationalist Press Association, Ltd., a sixpenny edition of a selection of Tyndall's lectures and essays from "Fragments of Science." The famous British Association address at Belfast in 1874 is included, and also the biographical sketch of Tyndall in the "Dictionary of National Biography."

SINCE its publication in 1881, Mr. W. Robinson's delightful book on "The Wild Garden" has been the means of introducing many lovers of plants to new and beautiful aspects of vegetation obtained by placing hardy exotic plants under conditions where they will thrive without further care. The fifth edition has just been issued by Mr. John Murray, and will appeal to a larger circle of readers than that which derived ideas from the original work. The illustrations are all woodcuts by Mr. Alfred Parsons.

THE first part of the fifteenth volume of the *Proceedings* of the Royal Physical Society of Edinburgh, a copy of which has been received, deals with the work of the session 1901–1902. In addition to the opening address by Dr. David Hepburn, vice-president of the society, on some morphological evidences of the evolution of man, the volume contains, amongst others, papers by Mr. Goodchild on the origin of rock-salt and on observations upon the bathymetrical distribution of reef-building corals, and one by Dr. Munro on the prehistoric horses of Europe and their supposed domestication in Palæolithic times.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mrs. Watkins; a Ring-tailed Lemur (*Lemur catta*) from Madagascar, presented by Mr. H. P. Jaques; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Captain C. P. Harvey; two Kinkajous (*Cercoleptes caudivolvulus*) from South America, presented by Miss C. Wallace Dunlop; a Himalayan Whistling Thrush (*Myiophoneus temmincki*), a Blue-winged Siva (*Siva cyanouroptera*), a Lesser Blue-winged Pitta (*Pitta cyanoptera*) from the Himalayas, presented by Mr. E. W. Harper; a Cardinal Grosbeak (*Cardinalis virginianus*) from North America, presented by Mrs. F. S. Stevenson; a Greek Tortoise (*Testudo graeca*), European, presented by Mrs. F. Bailey; two Wanderoo Monkeys (*Macacus silenus*) from Malabar, a Common Crowned Pigeon (*Goura coronata*), a Sclater's Crowned Pigeon (*Goura sclateri*) from New Guinea, a White-throated Ground Thrush (*Geocichla cyanonotus*), a Bengal Pitta (*Pitta bengalensis*), two Indian Rollers (*Coracias indica*), three Pond Herons (*Ardeola grayi*), five Scarlet-backed Flower-peckers (*Dicaeum cruentatum*), two Two-banded Monitors (*Varanus salvator*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN AUGUST:—

August	2.	8h. 1m. to 11h. 5m. Transit of Jupiter's Sat. III. (Ganymede).
	8.	13h. 10m. to 15h. 56m. Transit of Jupiter's Sat. IV. (Callisto).
	9.	11h. 27m. to 14h. 32m. Transit of Jupiter's Sat. III. (Ganymede).
	10–13.	Epoch of the great Perseid meteoric shower (Radiant point $45° + 57°$).
	12.	11h. Venus at maximum brilliancy.
	13.	10h. 54m. Minimum of Algol (β Persei).
	15.	Venus. Illuminated portion of disc $=0{\cdot}236$; of Mars $= 0{\cdot}877$.
	16.	14h. 50m. to 17h. 54m. Transit of Jupiter's Sat. IV. (Callisto).
	19.	13h. 16m. to 13h. 46m. Moon occults λ Geminorum (Mag. 3·6).
	28.	Perihelion Passage of Borrelly's comet (1903 *c*).
	29.	Mars $1\frac{1}{2}°$ south of α Libræ (mag. 2·9).

PHOTOGRAPHS OF COMET 1902 *b*.—Prof. R. H. Curtiss reproduces on their original scale, and minutely describes, some excellent photographs of Perrine's comet (1902 *b*) in the Lick Observatory *Bulletin*, No. 42.

The photographs were secured with the Pierson camera, which has a Dallmeyer objective of 15cm. aperture and 82.6cm. focal length, the Floyd telescope of 12cm. aperture and 200cm. focus serving as a guiding telescope. The nine photographs reproduced show very clearly the remarkable changes which took place in the size and form of the comet's tail.

THE NEW OBSERVATORY FOR BULUWAYO.—The *Buluwayo Observer* for March 21 gives an interesting account of the new observatory which is being founded in that city by the Jesuit mission.

Father Goetz, who obtained brilliant successes at the Paris University, and for eighteen months has been working at the Georgetown (U.S.A.) Observatory, has been appointed director, and has taken with him a fairly complete outfit of instruments for magnetic and meteorological observations. It is proposed that, as the work progresses, other instruments for astronomical work shall be added, and part of the programme for the new observatory is to undertake the mapping and cataloguing of variable stars in the southern hemisphere on similar lines to those followed at Georgetown for the northern variables. For this purpose the mission negotiated for the loan of an equatorial telescope from the Carnegie Institution, but the negotiations have not yet been successful.

The Chartered Company has given two blocks of land for the observatory site, and the Government has granted assistance in the erection of the necessary buildings (*Zambesi Mission Record*, July).

THE SYSTEM OF ϵ HYDRÆ.—In No. 36 of the Lick Observatory *Bulletin* Prof. Aitken gives the details of, and discusses, his observations of the binary system ϵ Hydræ, which, since its discovery by Schiaparelli in 1888, has been observed to possess a rapid motion. The various observations, except those made at Greenwich, are satisfactorily represented by an ellipse having the following approximate elements:—

$$T=1901{\cdot}1,\ P=15{\cdot}7 \text{ years},\ e=0{\cdot}685,\ a=0''{\cdot}24.$$
$$\Omega=109°{\cdot}5,\ i=35{\cdot}5,\ \lambda=264{\cdot}7,\ n=+22{\cdot}293.$$

The components differ fully two magnitudes in brightness, and their maximum separation is only $0''{\cdot}25$.

There is a third star at a distance of $3''$ forming, with the close double, the double star Σ 1273, and the observations show that together they form a ternary system, whilst the spectrograms obtained with the Mills spectrograph, and measured by Dr. H. D. Curtis, show that this third star has a line of sight velocity varying from $+45{\cdot}2$ on November 28·02, 1899 (G.M.T.), to $+29{\cdot}1$ on November 7·06, 1901, and that the visual and spectrographic binary systems are identical. If this is correct the spectrum observations should show a slow increase in the velocity of recession for the next year or two, and then a nearly uniform velocity until 1912.

WAVE-LENGTHS OF SILICON LINES.—Supplementing his recent work on the wave-length of the magnesium line at λ 4481, Prof. Hartmann has now redetermined the wave-lengths of the two silicon lines at λ 4128 and λ 4131, and has published his results in No. 1, vol. xviii. of the *Astrophysical Journal.*

These two lines, which are of great importance in the discussion of stellar spectra, generally appear broad and hazy in laboratory spectra, but, by photographing the spectrum of Geissler tubes containing silicon tetra-fluoride at low pressure, Prof. Hartmann has obtained them as sharply defined lines, from measurements of which he has obtained 4128·204 and 4131·040 as their respective wave-lengths, these values being based on Kayser's wave-lengths for three iron lines, viz. λ 4118·709, λ 4132·217 and λ 4144·033.

By similar means he has redetermined the wave-length of the carbon line at λ 4267, and gives 4267·301 as its exact value.

THE ECLIPSE OF THE MOON, APRIL 11–12.—In the July number of the *Bulletin de la Société Astronomique de France* a large number of photographs of this eclipse, obtained by various correspondents of the society, are reproduced. The photographs were obtained with many various instruments, and they, together with the remarks accompanying them, emphasise the exceptional density of the earth's shadow during this eclipse.

A METHOD OF APPLYING THE RAYS FROM RADIUM AND THORIUM TO THE TREATMENT OF CONSUMPTION.[1]

THE successful results reported in the treatment of rodent cancer by the rays from radium, and the general germicidal action of the rays, make the discoveries and investigations by Prof. Rutherford of the radio-active emanations of radium and thorium of great possible importance to medical men. The present article deals with the manner in which these emanations can be inhaled into the lungs and be made the means of applying the rays from radium and thorium to the treatment of consumption, in the hope that medical men will be induced to undertake research in this field. The rays from radium and thorium are very similar in kind, but differ greatly in relative degree. Five minutes' application of radium would be about equivalent to ten years' application of the same weight of thorium. Both elements continually and spontaneously produce radio-active emanations, or gases in infinitesimal quantity, beyond the present means of chemical or spectroscopic detection, but endowed with very considerable powers of giving out rays on their own account of exactly similar kind to the rays from radium and thorium themselves. The best condition for the free escape of these emanations, so that they can mingle with the air the patient breathes, occurs with both radium and thorium compounds when they are dissolved in water. In the solid state the emanations are often stored up by the salt and do not escape. Three-quarters of the normal activity of a dry solid radium compound is due to the stored up emanation. This escapes into the air instantly when it is dissolved in water.

If the air containing the emanation is removed and stored in a gas-holder away from the radium, the quantity slowly diminishes, and the radium solution grows a fresh crop as fast as the old disappears. In four days one-half of the emanation removed has disappeared, and one-half has reappeared in the vessel containing the radium solution, provided, of course, that it has been closed air-tight in the interval. After about three weeks the amount of the old emanation remaining is negligibly small; the amount re-formed is a practical maximum, the same as was originally obtained on dissolving the solid salt. In the case of thorium one-half of the emanation disappears or is reproduced, as the case may be, in one minute. In five minutes the old emanation has practically all disappeared, and the thorium solution, if kept in a closed bottle, again contains as much as it ever did or can contain. In three weeks for radium, and in five minutes for thorium, an equilibrium in the amount of emanation present is reached, as much disappearing as is reproduced, in the same way as the population of a country remains constant when the number of births in any given time equals the number of deaths.

These considerations regulate the "dosage." The longer a patient breathes through a thorium solution the greater the dose of emanation. With radium, however, once the emanation has all been inhaled, no further effect is produced, and the solution must be left tightly closed to recover its emanation before it can again be advantageously used. Further, in dealing with the thorium emanation, it is essential that the air should reach the patient's lungs within the shortest possible time, say half a minute, after leaving the thorium solution.

The property of the emanations of leaving behind a film of radio-active matter wherever they come into contact, which causes the phenomenon of "excited" or "induced" radio-activity, is important in the present connection, because this excited activity will remain in the air-cells of the lungs after the emanations themselves have been exhaled. This excited activity gradually disappears in the course of time, becoming negligible with thorium after two days, and with radium after three or four hours. The practical effect of this in both cases will be to cause a feebler continued action of the rays on the lungs after the more powerfully radio-active emanations have all been exhaled.

Which emanation will prove the more suited for the present purpose is, of course, a matter for trial, but thorium possesses many compensating advantages which make up for its very feeble radio-activity. It is cheap, and can be procured in any quantity. Unlike radium, the effect of its emanation is proportional to the time of inhalation. Moreover, in dealing with the emanation there is practically no limit to the quantity effectively employable. The radiation from a solid salt, owing to absorption of the rays by the salt itself, is practically confined to a thin surface layer, but with the emanation no such absorption occurs. The emanation from a kilogram or more of thorium salt could be effectively employed on the lungs of a single patient. Thorium nitrate, a very soluble salt, is the most suitable compound to employ, but the free nitric acid present should be neutralised after the salt has been dissolved in water by cautious addition of ammonia with stirring, until precipitation is about to take place. A gas washing bottle, with outlet and inlet tubes ground in, could be used as the inhaler, and this should be filled as full as possible with the moderately concentrated solution. There is not much fear that an hour's daily inhalation of the emanation from 100 grams of dissolved thorium nitrate would produce any ill effect, and both the quantity employed and the time of inhalation could, after due trial, be increased indefinitely. For use with the radium emanation the inlet and outlet tubes should be provided with taps. A few milligrams of the salt, radium bromide, for example, should be placed in the dry bottle, and water drawn in to dissolve it, the taps being then closed. For the first trials, a few bubbles only of the total gas contained in a fairly large bottle should be drawn into the lungs with a deep breath of air, and retained as long as possible before being exhaled. The dose should be only very gradually increased, and the effect on the system very carefully watched, for the radium emanation is an exceedingly powerful agent. Mixed with air it glows brightly in a dark room, and exerts a very rapid oxidising action on carbonaceous matter, and even on mercury. The maximum possible dose for any one quantity of radium solution would be obtained by inhaling the whole gaseous contents of the bottle, a few bubbles at every breath, once every twenty-four hours.

The immunity of these processes from external interference, the simple nature of the treatment proposed, the infinitesimal quantity of the active agents employed, the manner in which the emanations may be inhaled to do their work at the very seat of the disease, leaving behind in their place the excited activity to continue the work in a gentle manner after they have been exhaled, make out a strong case why the attention of medical men should be directed to these new weapons which physics and chemistry have placed at their disposal. Indeed, if nature had designed these phenomena for the purpose proposed, it is difficult to see in what way they could be improved upon.

FREDERICK SODDY.

[1] Abridged from the *British Medical Journal*, July 25.

THE CHEMISTRY OF THE ALBUMINS.

THE composition and constitution of the albumins have hitherto been studied almost exclusively from the analytical point of view, and particularly by the examination of the products of hydrolysis effected by either acids, alkalies, enzymes, or putrefactive bacteria.

Improved methods for the separation of these products, due to Kossel, E. Fischer, and others, have led to the conception of the complex albumin molecule as composed of a large number of simple molecules, consisting to a great extent of monamino- and diamino-acids and related compounds (compare NATURE, vol. lxv. p. 90), united together by some form of condensation, which involves an amino-group, and is probably similar in nature to that which occurs in the formation of the acid amides.

The various members of the vast group of albuminous substances may differ from one another in many ways, but two of the chief points of difference appear to be the variety of these component groups, and the numbers of them contained in a single molecule. Thus a comparatively simple albuminoid substance, such as silk when it is completely hydrolysed, yields, among other products, the monamino-acids, tyrosine, phenylalanine, leucine, alanine (amino-propionic acid), and glycine (aminoacetic acid). Gelatin, on the other hand, which is also comparatively simple in composition, differs markedly from silk by the absence of tyrosine, whilst oxyhæmoglobin, to take another instance, yields tyrosine, but no glycine.

By the incomplete hydrolysis of the fibroin of silk, moreover, Prof. E. Fischer has obtained a substance which appears to be a compound of aminoacetic and amino-propionic acids. The formation of this substance is of great interest, since it probably represents an intermediate stage of the decomposition, and affords strong confirmation of the view of the constitution of the proteid molecule which has just been stated.

Most of the final products of hydrolysis of the albumins are familiar compounds which can readily be prepared by synthetic methods, but very little has hitherto been known of the more complex substances to be obtained by the linking together of several of these molecules. It is in this direction that Prof. Emil Fischer has been working for some time past, and he has contributed to the current number of the *Berichte* an account of the highly important results which have already been attained. The plan of attack consists in endeavouring to build up complex substances from the simple amino-acids by first introducing a second molecule of the same or another acid, and then repeating the process as frequently as possible with each successive product.

The first step was taken some time ago by the production of glycylglycine, $NH_2.CH_2.CO.NH.CH_2.CO_2H$, from glycine anhydride. This substance contains two molecules of glycine united in the typical manner, and is the simplest of the *polypeptides*, as these bodies have been named, because of their assumed similarity to the peptones in structure. To add a third link to the chain is, however, a matter of difficulty, owing to the ease with which the amino-group undergoes change. Two methods have, however, been found by means of which this can be accomplished.

The first of these consists in building up the new amino-acetic molecule by first introducing into the amino-group the chloracetyl radical, $Cl.CH_2.CO.$ (by the action of chloracetyl chloride), and then introducing the amino-group by the action of ammonia, the final product being a crystalline substance having the formula of a diglycylglycine, $NH_2.CH_2.CO.NH.CH_2.CO.NH.CH_2.CO_2H$. A description of the properties and reactions of this substance has, unfortunately, not yet been published.

The other method consists in first of all introducing the group $.CO_2C_2H_5$ into the amino-group of glycylglycine. The resulting compound can then be converted into an acid chloride, which readily reacts with the ester of glycine to form the desired compound containing three glycine molecules. A repetition of this process leads to the addition of a fourth glycine molecule to the chain, the final product which has hitherto been obtained being of the respectable complexity shown by the formula

$$CO_2C_2H_5.NH.CH_2.CO.NH.CH_2.CO.NH.CH_2.CO.NH.CH_2.CO_2C_2H_5$$

(carboxethyl-triglycylglycine ester). This substance is crystalline and is converted by ammonia into a crystalline amide, which gives, with an alkali and a copper salt, the well-known biuret reaction, which is given by all the amides of this series, as well as by the albumins. The group $.CO_2C_2H_5$ combined with the amino-group cannot, so far, be removed from the molecule, so that, until some means of doing this is discovered, this method can scarcely be expected to yield derivatives so closely related to the actual proteids as those obtained by the method first described.

Both methods obviously lend themselves to the production of a great variety of compounds containing different amino-acid groups, and substances of this kind, derived from glycine and leucine, and from glycine and alanine, have already been prepared. It seems probable that by their extended use compounds of the order of complexity of the peptones or albumoses may soon be prepared. The application of both methods is, indeed, still in its infancy, but we can have little doubt that the genius which laid bare the innermost secrets of the sugars will succeed in solving many of the problems which surround the chemistry of the albumins.

ARTHUR HARDEN.

THE ANTARCTIC EXPEDITIONS.

THE report of Captain Scott to the presidents of the Royal and Royal Geographical Societies, which is printed in the July number of the *Geographical Journal*, adds a number of points of geographical interest to those previously published, especially with regard to the great southern ice-barrier, and the nature of the lands discovered by the British expedition; while the map published at the same time, which has had the advantage of revision by Lieut. Shackleton since that officer's arrival, permits the details of the narrative to be followed with much clearness, although it is still to be considered merely provisional.

The voyage down the east coast of Victoria Land brought to light some new features in the configuration of the country. Thus, in about lat. 75° 30′, an enormous floe of the inland-ice was seen to descend into the sea and extend for many miles to seaward, closely resembling the Great Barrier and the barrier formation which entirely fills Lady Newnes Bay. Near the entrance to MacMurdo Strait (between Erebus and Terror Island and the mainland), ice-cliffs, 150 feet high, were again skirted, being evidently the seaward face of the great glacier subsequently explored by Lieut. Armitage. During the voyage eastward along the face of the Great Barrier, soundings for some time showed depths of more than 300 fathoms, the barrier edge being very irregular, and varying from 30 to 215 feet in height. In the neighbourhood of the eastern land discovered by the expedition (King Edward VII. Land) the soundings suddenly became less, varying from 70 to 100 fathoms. The bare patches seen among the snow slopes of the new land, which are evidently the sharp spurs of snow-capped hills, stand at a height of 2000 to 3000 feet. The balloon ascent and sledge expedition made in long. 196° 15′, showed that the surface of the barrier[1] undulated in long waves running W.S.W. and E.N.E. It was noticed that here the ship neither rose nor fell in relation to the ice, thus apparently indicating that the latter is floating.

The winter quarters were established in February, and the magnetic observatory was in readiness for the term-day observations of March 1, all the subsequent term days being kept by Mr. Bernacchi without a break. On May 3 a strong southerly gale brought the first heavy snowfall, also blowing the strait clear of ice to within 200 yards of the ship. Mr. Hodgson was constantly engaged on his biological work, keeping holes open for his nets and fish-traps, and all the officers assisted Lieut. Royds in the night meteorological observations. Auroral displays were infrequent and feeble, but were carefully observed. The winter sledge reconnaissances revealed much of the topography of the neighbourhood, both on the south side of Erebus and Terror Island, and between it and the mainland, where there are three smaller islands, named White,

[1] The whole southern ice-sheet is spoken of throughout as the "barrier," though this term would more naturally apply to its northern face only.

Black, and Brown, from their characteristic aspects; the first being snow-covered, while the two others displayed the bare basaltic rocks of which they are composed. In September and October minimum temperatures of −51° and −57° F. were experienced during two of the journeys.

During a visit to Mount Terror, the eastern slopes of which are terribly wind-swept and bare to the summit, Mr. Skelton made a perilous descent to the sea-ice, and was so fortunate as to discover a breeding-place of the Emperor penguin, obtaining several specimens of the young in down, besides photographs and notes. The attacks of scurvy which occurred about this time, brought about by severe work and exposure, were in reality very slight, and their importance has been much exaggerated, all symptoms quickly disappearing when the diet was restricted to seal-meat. Skua gulls, which were also obtained, were found to be excellent eating.

The southern sledge expedition undertaken by the Commander, with Lieut. Shackleton and Dr. Wilson, was carried out entirely on the surface of the great ice-sheet, it being found impossible to reach the land, though it was sufficiently near to allow of observations as regards the bearing and altitude of the different land-masses, as well as sketches and photographs. A remarkable feature seems to be the fiord-like openings by which it is penetrated at various points, though the intervening volcanic masses rise into magnificent ranges of mountains. These openings had the appearance of straits, nothing being seen behind, though the state of the ice-sheet opposite them showed that ice must be pressing out through them. On approaching the land at the furthest south, the ice-sheet was found to be separated from it by an immense chasm, the ice-foot resembling that seen elsewhere at the sea-margin of the lands, and forming a complete bar to further progress. The return journey was rendered difficult by the nature of the surface and the prevalent mist.

The further details supplied of Lieut. Armitage's western expedition show that, after proceeding up one large glacier, lying between precipitous granite mountains, a ridge was crossed by a pass 4000 feet above the sea to a second glacier, which had a general trend from south-west to north-east. Its right-hand branch was ascended to a range of remarkably bare granite mountains, the ice surface being much crevassed. A line of sticks set up during the ascent showed a maximum motion of 3 feet 8 inches in twenty-three days. On gaining a height of 9000 feet a smooth, open snow-covered plain stretched to the westward, its surface being soft, with successive crusts nine inches or a foot apart. There were no *sastrugi*. The whole horizon to the west was clear and unbroken, and the plain appeared to have a slight fall in this direction. Running streams, 7 feet wide, with occasional pools sometimes a mile in diameter, were seen on the return journey, and *Bergschrunds* 150 feet deep were found at the base of the mountains. Among the other journeys described, those of Dr. Koettlitz for the investigation of the ice and esker-like lines of débris in the neighbourhood of the Black and Brown Islands are of most interest.

An interesting complement to the narrative of the British expedition has been supplied by the report of Dr. von Drygalski, leader of the German expedition in the *Gauss*, which was published as a supplement to the official *Reichsanzeiger* on July 10. It describes the voyage from Kerguelen *viâ* Heard Island to the supposed position of the non-existent Termination Land, the southward advance to a previously unknown land, in the vicinity of which winter quarters were established, the scientific work done at the winter station, and the sledge journeys undertaken during the stay. The *Gauss* was frozen fast in the ice to the north of this land, the pack there remaining stationary owing to the shallowness of the sea over the "Continental Shelf." Only a few miles to the north it appears to be kept constantly in motion by the heavy swell caused by the westerly storms, which would have seriously impeded the scientific work, besides endangering the ship. From the land rose a bare volcanic peak 1200 feet high, which was named the Gaussberg. The *Gauss* was set free on February 8 by a strong easterly wind, but was caught again temporarily in a somewhat lower latitude, the final start northward being made on April 8, when the lengthening nights were already making navigation difficult.

THE STRUCTURE OF SPECTRA.[1]

THIS paper gives a very lucid account of the structure of various types of spectra, special attention being directed to the work on "series" which has been performed during recent years.

After referring to the splendid work performed by Ångström and Rowland in establishing trustworthy tables of standard wave-lengths, the author passes on to the evolution of the definite laws which have been found to govern the distribution of lines in the spectra of many elements, comparing the occurrence of similar definite groupings of lines in the spectrum of a substance to the "harmonics" obtained in acoustics.

In 1863 Mascart found that certain groups of lines of characteristic aspect were reproduced in different parts of the spectrum of the same metal, *e.g.* he found that similar triplets to the "b" group of magnesium were reproduced in the ultra-violet region of the spectrum of that metal. To-day it is known that altogether there are fourteen such groups in the magnesium spectrum, one in the infra-red, the "b" group and twelve in the ultra-violet.

Similarly in the spectrum of sodium there are twelve such "doublets" as that commonly known as D_1 and D_2 in the solar spectrum. If these "triplets" and "doublets" are represented on a scale of wave-lengths, they contract as they approach the ultra-violet, but if they are represented on a scale of frequencies, the groups of the same metal become identical, and are absolutely superimposable. Similar groups have been found for a large number of metals by Kayser and Runge.

The alkaline metals, like sodium, give a series of "doublets," as also do copper and silver, whilst the divalent metals (Mg, Ca, Sr: Zn, Cd, Hg) give triplets, although some of them, *e.g.* Hg, are so mixed up with other groups that at first this arrangement is difficult to recognise. Here then we have a simple law, which should be credited to Rydberg, viz. "In the spectra of a large number of elements there exist groups which are reproduced several times, the interval which separates the individual lines of each group (when represented on a scale of 'frequencies') being exactly the same for all the groups."

For the alkaline metals the length of the interval which separates the doublets varies as the square of the atomic weights, as is shown in the following table:—

Metal	Atomic weights (P)	Length of interval (ν)	$\nu/P^2 \times 10^4$
[2] Li	7	—	—
Na	23	0·17	3·25
K	39	0·57	3·81
Rb	85	2·34	3·22
Cs	133	5·45	3·09

It was then found that these groups arrange themselves in regular series capable of mathematical expression, and in 1885 Balmer found that on plotting the thirteen lines of hydrogen on a curve which had "m" (the number of the line counting in order from "3" in the red to "15" in the ultra-violet) for its abscissa and N (the frequency) for its ordinate, he obtained a perfectly regular curve which could be exactly expressed by the formula

$$N = B/4 - B/m^2,$$

where B was a constant. Later, Messrs. Hales and Deslandres discovered sixteen other hydrogen lines in the spectra of prominences and various stars, and it was found that these also might be represented by the above formula.

The spectra of metals also arrange themselves in similar series, although the relations are not so easily seen at first, because of the overlapping of the other lines. However, the spectrum of potassium may be taken as an example, and we find that on plotting the lines in a similar manner we obtain three such series, known respectively as "the principal," "the first subordinate," and the "second subordinate" series. In each of these series the brightness of the lines decreases as they approach the more

[1] "La Structure des Spectres," by Prof. Ch. Fabry, Marseilles, in the *Revue Générale des Sciences*, No. 5, March 15.

[2] The "doublets" for lithium have not been observed, but if the law is applicable in this case the interval would only be 0·016, which is too small to be observed.

refrangible end of the spectrum, acting in this respect in a manner analogous to the hydrogen lines. It is found that the potassium curve is exactly similar to the hydrogen, having a horizontal asymptote which corresponds to the limit of the series. Not only is it similar to the hydrogen curve, but by making two displacements parallel to the coordinates it is found to be superimposable, and both curves may be represented by a generalisation of Balmer's formula, due to Rydberg, as follows:—

$$N = A - B/(m+\mu)^2,$$

where A, B and μ are constants, B having sensibly the same value as in Balmer's formula.

It is interesting to compare the curves for the various members of the alkaline metals among themselves, when it is seen that both for the "principal" and the "subordinate" series the limits approach the red end of the spectrum in the order of the atomic weights of the metals, as if the greater masses of the atoms caused the frequencies of the vibrations to become less; this same fact becomes obvious when we consider, similarly, the spectra of the other metals classified into their natural groups.

Prof. Fabry next describes the "satellites" which accompany most lines in the several spectra. For an example he takes the spectrum of mercury, which is composed of triplets forming two series, one the "diffuse" and the other the "sharp" ("first subordinate" and "second subordinate" respectively) series of Rydberg. In the "diffuse" series the first element of each group is composed of four lines, the second of three and the third of two, but in the "sharp" series the elements are apparently single lines; this is probably due, however, to the very close proximity of the satellites in the latter series, and in several cases MM. Fabry and Perot have shown that, with special apparatus having great resolving power, these lines are of a compound nature, and have come to the conclusion, which at least is probably the correct one, that *all* the elements of the secondary series are accompanied by satellites. All these satellites appear to share the common property of varying greatly under different conditions of emission (*e.g.* as temperature, pressure and nature of the electric discharge), and these two observers have shown that, whereas the silver line at λ 547·2, which is a satellite of the line at λ 546·6, appears in the spark spectrum in air, it completely disappears when the spark takes place *in vacuo*. Many metals (*e.g.* Fe, Ni, Mn) produce spectra so complex that, as yet, it has not been possible to classify them, but this may be done when a means of distinguishing analogous rays is discovered and brought into use.

This latter means may be found when the phenomena first observed by Zeeman, and known as the "Zeeman effect," have received a more complete study. This observer found that if the emission took place in a strong magnetic field, each line was split up into a series of lines symmetrically placed as regards the original line, but differently polarised. Taking the spectrum of mercury as an example, we see that the second subordinate series is made up of triplets, or, as shown above, three separate parallel series of lines, which one may call, in this explanation, "a," "b" and "c" respectively. In the magnetic field the members of the "a" series split up into nine separate lines, *four* on each side of the original line, some of which are polarised in the plane of the lines of force, the others in the perpendicular plane, but the corresponding line on each side is similarly polarised. In the "b" series we get lines which are similarly placed as regards the original line, and similarly polarised, but there are only *three* on each side, the second member on each side in the "a" group having disappeared. Similarly in the "c" series only two extraordinary lines are seen, *one* on each side of the original, corresponding to the extreme lines in the "a" series.

To the first workers in this field these lines appeared greatly entangled, but, thanks to the labours of Cornu, Michelson, Preston, and more especially Runge and Paschen, order has been evolved from the chaos, and the study of the "Zeeman effect" will, in the future, form a ready means of recognising and determining series, for it has already been proved that "the various lines which go to make up similar series behave in an identical manner when the emission takes place in a magnetic field, and if one represents each line by its 'frequency,' the various members, in the same magnetic field, resolve themselves into groups which are strictly superimposable." It is also to be hoped, and even expected, that when the work of Humphreys and Mohler, and others, on the displacement of spectral lines under various conditions of pressure, comes to be further developed, similar laws as to the analogous behaviour of lines in their corresponding series will be evolved.

Prof. Fabry concludes his article with a discussion of the relations which exist between the absorption and emission of the same radiations, taking the example of the telluric absorption assigned to atmospheric oxygen in the solar spectrum as an example for discussion. He doubts the coincidence of these absorption bands with emission lines in the spectrum of the gas, although, as he points out, experimental means of proving their non-coincidence have yet to be devised.

CONGRESS OF THE SANITARY INSTITUTE.

THE annual congress of the Sanitary Institute was held at Bradford on July 7–11, under the presidency of the Earl of Stamford.

In his inaugural address Lord Stamford dealt with the history of hygiene, showing how closely the subject was allied to political, social and economic history. In describing broadly the various sanitary questions as they affected the home, factory, and the municipality, the president dealt with the important subject of school hygiene, and pointed out how essential it was that the training schools for teachers should form part of the coordinated system of national education. It should be one of the first requirements in the preparation of the teacher, and also of the inspectors who are appointed to visit the schools, that they should practically understand something of the nature of the child material upon which they are to work, the conditions under which the child can best develop by the teacher's guidance, and the proper use of the appliances provided in modern school buildings.

The sections and conferences to which the papers and discussions of the congress were allotted were presided over by well-known representatives of different sciences connected with hygiene. Prof. Clifford Allbutt, in his address on sanitary science and preventive medicine, brought forward for consideration the question if, within limits, the birth of fewer children under improved conditions may be better in the end than a more voluminous birth-rate of children of which some may be of lower vital capacity, and many less watchfully reared.

Mr. Fitzmaurice, of the London County Council, presided over the section of engineering and architecture, and in connection with some of the large engineering works in which he had been engaged he directed attention to the duty of providing for the medical and sanitary requirements of the large bodies of men temporarily collected for the purpose of carrying out the works, and showed that attention to these requirements was an economic advantage. In works like the Forth Bridge or others in the neighbourhood of large towns the difficulty could be overcome, but in works abroad, such as the Nile reservoir, the problem was a more difficult one, especially as smallpox and typhoid are endemic in the Nile valley, and a large outbreak of either in a camp where 15,000 persons were at times employed would have been disastrous; but by making careful provisions, health conditions were so well maintained that, during the five years the works were going on, there were only four deaths from smallpox and one from typhoid fever. He also dealt with the health aspects of cheap locomotion to the suburbs, and motor traffic.

Prof. Hunter Stewart, in addressing the section of chemistry, physics, and biology, discussed the spread of and immunity from Asiatic cholera, and referred to Great Britain as the most striking instance of acquired immunity. With a sea traffic from India greater than that of any other European Power, and in constant communication with the Mediterranean ports, with no quarantine and cordon regulations such as prevailed on the continent of Europe, this country has, since 1866, known cholera only in the sporadic

form, even though it was raging as an epidemic in France and Spain in 1884–1885. This immunity may be attributed to the great measures for sewage and refuse removal carried out in Britain, which had slowly resulted in such a purification of the soil as to make it unsuitable for conferring virulence on the micro-organism of cholera.

Among the subjects discussed in the sections were the notification of consumption, the several aspects of sewage disposal, construction of hospitals and public baths, and disinfection.

In addition to the sections, eight technical conferences were held dealing with the aspects of hygiene, particularly in reference to the different professions and various classes of the community.

In connection with the congress an exhibition of sanitary apparatus and appliances was arranged, containing exhibits brought by manufacturers from all parts of the country. The visits made to the various municipal undertakings and sanitary works in the neighbourhood served as a valuable object-lesson, illustrating many of the matters discussed in the meetings of the congress.

Among the exhibits at the exhibition, which were carefully examined by a board of expert judges, a special Rogers Field medal was awarded by the institute to the Northern Vacuum Cleaning Company for their apparatus for cleaning carpets, furniture, and house decorations without removing them from the house. The attendance of members and delegates numbered 1550.

E. WHITE WALLIS.

THE MUSEUMS ASSOCIATION.

THE fourteenth annual congress of the Museums Association was held in Aberdeen on July 13–16, and although the place of meeting was so far north, the attendance was exceptionally good, while the programme of business was one of the most varied and useful that has ever been brought before the Association. The president for this year is Dr. F. A. Bather, assistant keeper of geology, British Museum (Natural History), whose presidential address dealt chiefly with art museums. After defining generally the purport and breadth of museums, which he classified into three divisions, (*a*) investigation for the benefit of specialists; (*b*) instruction for the benefit of students; and (*c*) inspiration for the guidance of the general visitor, he entered into a critical survey of the Museum of Fine Art, specially condemning the present system of arranging pictures, and the lack of harmony between the architecture, decoration, and contents of an art gallery.

Mr. James Murray followed with a paper on the Aberdeen Art Gallery, which is about to be greatly extended; then came a paper by Mr. Alex. M. Rodger, "Method of Mounting Fish with Natural Surroundings," which can be commended to all curators who wish to make their museums attractive. Mr. W. P. Pycraft was rather severe on some of the methods of representing birds in a museum, and Mr. E. M. Holmes briefly described a method of preserving the natural colours of dried leaves and flowers for museum specimens, which had stood the test of many years' exposure, while a paper by Mr. H. Bolton treated of the "Re-shelving of Museum Cases." "On Good Form in Natural History Museums" was the title of a paper by Mr. F. Jeffrey Bell; another paper of the same character being "Neglect of Opportunities," by Mr. S. S. Buckman.

In addition to representatives from the leading museums of Britain, there were some foreign representatives who read papers. Dr. Jens Thiis, director of the Nordenfjeldske Kunstindustri-museum, Trondhjem, explained the practical work connected with that museum; Dr. G. Johanson Karlin, of the Kulturhistoriske Museum, Lund, gave some good advice in his paper on the museum system; while Dr. O. Lehmann, of the Altona Museum, advocated the cultivation of the habit of drawing in natural history museums.

Other papers were contributed by Prof. T. D. A. Cockerell, of the New Mexico Normal University; Dr. Anton Fritsch, of the Bohemian Museum, Prag; Mr. B. H. Woodward, of the Perth Museum, Western Australia; and Prof. Wm. M. Ramsay, of Aberdeen, who treated of the archaic art of the north-east of Scotland, and the urgent necessity for the preservation of existing examples of it, while Prof. J. Arthur Thomson, in a convincing paper, showed the need for a faunistic museum for the north of Scotland. All these papers, together with the discussions which they aroused, will be published in due course in the *Museums Journal*. The invitation of the City of Norwich to hold the conference in 1904 in that city was accepted, and Dr. S. F. Harmer, superintendent of the Museum of Zoology, Cambridge, was elected president, Mr. E. Howarth, of the Museum and Art Gallery, Sheffield, being re-elected secretary and editor.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE third reading of the London Education Bill was carried in the House of Commons on July 22, and the second reading passed the House of Lords on July 28. The measure will, therefore, doubtless soon be placed upon the Statute-book.

THE following awards have been made under the research scheme of the Carnegie Trust for the universities of Scotland, in addition to those announced last week:—*Research Scholarships.*—Pathological: Mr. C. T. Andrew, Mr. A. Matheson, Mr. M. Logan Taylor, Mr. S. A. K. Wilson. Economical: Mr. John Young.

MR. PHILIP J. HARTOG has been appointed academic registrar of the University of London in succession to Dr. H. Frank Heath, and Dr. E. R. Edwards secretary to the registrar of the board to promote the extension of university teaching, in succession to Mr. J. Travis Mills. The Drapers' Company has presented to the university the sum of 1000*l.* to be devoted to the assistance of Prof. Karl Pearson in his statistical researches at University College and in the higher work of his department.

THE Technical Instruction Committee of Leeds has decided to give support to the application of the Yorkshire College for the establishment of a university in Leeds, to be entitled Victoria University of Yorkshire, and, in the event of a Charter being granted, to give 4000*l.* per annum towards the university funds, in addition to the 1550*l.* granted from the "whisky" money. The finance committee also approved of the resolution. The *Gazette* of Friday last announces that a petition has been presented to the King in Council praying that a Charter be granted constituting an independent university in Sheffield.

AMONG many questions of educational interest considered in the report for 1902 of the council of the City and Guilds of London Institute is that of the relation between the amount of State aid for university and higher technical education and that of private munificence for the same purpose. The report states, "that State or public aid does not necessarily take the place of private and voluntary effort is shown by the experience of the United States of America. Notwithstanding the increasing revenue available there from the State land grants permanently assigned to education, the activity and munificence of private effort increases rather than diminishes, as shown by the large contributions which are continually being made to the principal universities and higher colleges. In the three months September to November of last year gifts to higher education, amounting in all to nearly five million dollars, equal to about one million sterling, have been publicly recorded." The report also shows that the executive committee of the institute has had under consideration the question of the length of the sessions of work of colleges providing systematic courses of higher instruction. It has been found that the number of weeks in the session at eight of the principal technical colleges in England varies from thirty-one to thirty-three, leaving between four and five months' vacation during the year. Vacations do not necessarily mean holidays, and in most colleges the work of advanced students continues into the vacations; nevertheless, the committee suggests that the length of the formal session might with advantage be increased.

TWENTY-EIGHT senior county scholarships and exhibitions have just been awarded by the London County Council Technical Education Board. The awards are made on the work and promise of the candidates, and most of the scholars will pursue their studies at universities or advanced

technical colleges. Among the awards we notice the following:—Mabel Gardner, who has gained the first science scholarship at Girton College, senior county scholarship of 90*l*. a year for three years. H. H. Mittell, a full senior county scholarship of 90*l*. a year for three years to enable him to proceed to Magdalene College, Cambridge, where he has gained an open scholarship, and to take the mathematical tripos. C. H. Pitt, a senior county scholarship of 90*l*. a year to enable him to proceed to Corpus Christi College, Cambridge, where he has won an open science scholarship. A. E. Baker, an exhibition of 75*l*. a year for two years in the first instance, in order to enable him to proceed to Trinity College, Cambridge, where he has obtained an exhibition and subsizarship, and to take the natural sciences tripos. W. H. Norris, an exhibition of 70*l*. a year for three years to enable him to proceed to Corpus Christi College, where he has gained an open science scholarship. J. W. Kuhrt, a free place at the London School of Economics and Political Science, together with an exhibition of 50*l*. a year for two years, in order to enable him to take the B.Sc. examination of the London University in economics. B. P. Williams, an exhibition of 50*l*. a year for two years, together with a free place at the college to enable him to take the B.Sc. degree in engineering. P. A. Houseman, an exhibition of 40*l*. a year for three years to assist him to proceed to Würzburg University for the study of chemistry. H. H. Hodge, an exhibition of 30*l*. for one year in order to enable him to travel on the Continent and study the French language and the French system of education.

THE Board of Education has recently published two sets of regulations, for the session 1903–4, for schools of various grades. One volume deals with secondary day schools, and does not appear to differ in any important respect from that of last year. The other contains regulations for all schools and classes in connection with the Board of Education which have not received attention in previous regulations already published for next year's work, such as evening schools, technical institutions, and schools of art and art classes. A circular letter respecting the latter volume has been issued by the Board, and describes for the benefit of managers of schools the important respects in which the regulations for next session differ from those of previous years. The volume may be said to concern all those institutions in which instruction of a specialised or technical character is given, whether in the day-time or in the evening, as well as evening schools and classes the scope of which may vary almost indefinitely with the attainments and aim of the students. The rule under which the rate of grant payable for science instruction given in the day-time was half the rate payable for such instruction if given in the evening is abolished, and grants for advanced instruction given during the day in technical institutions will now be assessed in accordance with regulations appropriate to the special circumstances of such instruction. The letter also urges the desirability of fixed salaries for teachers of classes of all kinds, and rightly insists that the amount of stipend should be in relation to the qualifications and experience of the teacher and the time given by him to the work of the class, and that cognisance should be taken of the time absorbed in preparing experimental lectures, in travelling, and in the correction of home-work. It is very satisfactory, too, to find that the new regulations definitely require a sufficient preliminary training for students in classes in scientific and technical subjects, and that every encouragement is given to managers to inaugurate a system of "courses of study" rather than one of isolated subjects in no way correlated.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 18.—"On the Synthesis or Fats Accompanying Absorption from the Intestine." By Benjamin **Moore**, M.A., D.Sc., Johnston Professor of Biochemistry at University College, Liverpool. Communicated by Prof. C. S. Sherrington, F.R.S.

The fats of the food are changed in the intestine into fatty acids and glycerine, and the fatty acids are then in part combined with alkali to form soaps.

Both soaps and free fatty acids have a very small solubility in water, and it is by the agency of the bile, in which both are much more soluble, that these constituents of the digested fats are made capable of being taken up in soluble form by the absorbing cells of the intestine.

The absorbed fatty constituents are not taken up by the blood stream, but pass by a separate system, namely, the absorbent lacteals of the intestinal area, to be finally carried to the circulating blood by the main lymphatic vessel, the thoracic duct.

Now, somewhere along the path of absorption, the absorbed soaps and fatty acids are recombined with glycerine to form fats, for in the thoracic duct after a meal containing fat only fats are found.

The seat of this transformation has not hitherto been known with accuracy, but in this paper experiments are quoted to show that the change occurs in the intestinal cells which first take up the consituents of the digested fat in soluble form, and not in the cells of the lymphatic glands of the intestine through which the absorbed fatty matter subsequently passes on its way to the thoracic duct.

This is shown by analyses of the fatty matter in the small lymphatic vessels leading from the intestine, which show that, even here before the absorbed fatty matter has reached the abdominal lymphatic glands, it has all been changed back into fat. A change in the same direction is shown by analyses for fatty constituents of the intestinal cells, but here the process is found in progress, and not yet complete.

It is further shown that the cell must be *in situ* and supplied with nutrient matter in order that this change can be brought about, for no synthesis of fat occurs when the isolated intestinal cell or extracts of it are allowed to act upon the fatty constituents *in vitro*. The only change then occurring is the formation from soap of free fatty acid, which is probably the initial stage in the change occurring in the living intact cell, and is further a protective action, which would prevent the entrance of the poisonous soaps into the circulation.

This demonstrates that the living cell supplied with energy by the nutrient matter which bathes it is capable of acting as an energy transformer for chemical energy, and of carrying out syntheses impossible for enzymes which cannot add energy to the ingredients upon which they act, and hence cannot carry out complex syntheses requiring the addition of chemical energy to those ingredients, as can the living cell.

"The Theory of Symmetrical Optical Objectives." By S. D. **Chalmers**, B.A. (Cantab.), M.A. (Sydney), St. John's College, Cambridge. Communicated by Prof. Larmor, Sec. R.S.

This paper deals with the relations between the aberrations of a lens system, used with a front stop, and those of the compound system formed by two such systems disposed symmetrically with respect to the stop. The results justify the practice of correcting a single component —the back one—for astigmatism and spherical aberration, *provided* due attention is paid to the securing of the condition for no distortion.

PARIS.

Academy of Sciences, July 20.—M. Albert Gaudry in the chair.—The manner of flow of a spreading sheet of water on a plane surface, applied to the case where the surface is curved, by M. J. **Boussinesq**.—On a new method for the detection and estimation of small traces of arsenic, by M. Armand **Gautier**. It is based on the principle that ferric oxide precipitated in the presence of arsenic carries down with it the whole of the latter, even in the presence of chlorides and other salts. The arsenic in the precipitate can then be directly estimated in a Marsh apparatus. In this way the thousand millionth of its weight of arsenic can be detected in a substance, and its presence was shown in the purest distilled water and many common reagents.—On the torsion movements of the eye when looking in certain directions, the socket remaining in the primary position, by M. Yves **Delage**.—On a new action produced by the rays *n*, and on several facts with regard to these radiations, by M. R. **Blondlot**. The rays *n* falling on platinum foil heated to dull redness cause it to glow more brightly. This effect is not due to increase of temperature. The increased brilliancy is observed on both sides of the

foil owing to the fact that cold platinum, which is opaque to these rays, becomes transparent on heating.—Study of the molecular deformations of a steel bar submitted to thrust, by M. L. **Fraichet.**—Photographs of the Borelly comet (1903 *c*), by M. **Quénisset.** These photographs were taken at the author's observatory at Nanterre, and in pairs, so as to give a stereoscopic representation.—On the theory of the acoustic field, by M. **Charbonnier.** The theory serves to explain certain photographs of projectiles obtained by Dr. Mach, of Vienna, and is the basis of Gossot's method of measuring the velocity of projectiles.—Contribution to the study of superheating, by M. A. **Petot.**—Sublimation curves, by M. A. **Bouzat.** A comparison of the sublimation curves of carbon dioxide, ammonium sulphide, and ammonium carbonate with the dissociation curve of the compound of silver chloride and ammonia.—On the law of recombination of ions, by M. P. **Langevin.** An expression is developed which gives the ratio of recombinations to the number of collisions between two ions of opposite sign, and is verified by comparison with the experimental values for air and carbon dioxide.—On commutation in continuous current dynamos, by M. **Iliovici.**—The influence of temperature on the dichroism of mixed liquids, and a proof of the law of indices, by M. Georges **Meslin.** Substances are chosen for which the value of the index of the liquid but very slightly exceeds the mean value for the solid. The change in sign of the dichroism with rise of temperature was experimentally verified in a number of cases.—On photographic spectrophotometry, by M. C. **Camichel.** Various catalytic reactions brought about by metals and the accelerating and retarding influences, by M. A. **Trillat.** Reactions between copper or platinum and the vapour of alcohols of oxidising, reducing, condensing, or saponifying effects. The reactions are considerably affected by traces of impurities, and the copper must first be tarnished by heating in air.—On ferrisulphuric acid and ethyl ferrisulphate, by M. A. **Recoura.** The ethyl ester is obtained by boiling the acid with alcohol as a yellow solid. On heating the acid, it loses simultaneously one molecule of sulphuric acid and two of water, leading the author to assign to it the formula $Fe_2O_3.3SO_3.H_2SO_4.2H_2O+6H_2O$.—Prussian and Turnbull's blues. A new class of complex cyanides, by M. P. **Chrétien.** A soluble acid blue or hydrodiferrocyanic acid, $Fe_2Cy_6H_13H_2O$, is obtained by the spontaneous decomposition of hydroferrocyanic acid at about 20°. It reacts with alkalis as follows:—$Fe_2Cy_6H + 4KOH = FeCy_6K_4 + Fe(OH)_3 + H_2O$. This and other reactions are studied thermochemically.—On spartein. General characteristics; action of some reducing agents, by MM. Ch. **Moureu** and A. **Valeur.** This communication contains a repetition of previous work on spartein, and an account of unsuccessful attempts to obtain reduction products.—On the isonitrosomalonic ethers and their conversion into mesoxalic ethers, by MM. L. **Bouveault** and A. **Wahl.** The methyl and ethyl ethers were obtained pure, and converted into the corresponding mesoxalic ether by means of nitrogen peroxide.—Action of ammonia on the compound of oxide of ethylene and *β*-*o*-cyclohexanediol, by M. Léon **Brunel.** With an excess of ammonia *o*-aminocyclohexanol is obtained; with less ammonia, more complicated substances.—Researches on the nutrition of etiolated plants, by M. G. **André.**—On the phospho-organic reserve material of plants, by M. S. **Posternak.** The method is given for the separation of this substance as the salt of an acid, CH_5PO_5, from seeds and other parts of plants. In this way 70 per cent. to 90 per cent. of the phosphorus in the seeds can be accounted for, lecithine representing only 1 per cent. to 7 per cent. of the phosphorus.—On roots trained by experiment to grow upwards, by M. H. **Ricome.** The plants (beans) were attached to the end of a long thread kept oscillating. The development of the root and longitudinal growth were perfectly normal.—A resinous Granadilla, by M. Henri **Jumelle.** The exudation from the base of the stem of this plant, the *Ophiocaulon Firingalavense*, is a resin rather than a wax, and contains 83 per cent. of true resin, which is deposited as an amorphous mass from solvents.—Contribution to the study of the Aepyornis of Madagascar, by M. Guillaume **Grandidier.** Particulars of the lower portions of a skeleton of the *Aepyornis ingens*.—On basic inclusions from the volcanoes of Martinique and St. Vincent, by M. A. **Lacroix.**—Contribution to the study of congenital changes in the nervous system, by MM. Claude **Vurpas** and André **Léri.**—On the organic respiratory gases in diabetes, by M. J. **Le Goff.** These gases contain acetone, which was separated as iodoform and estimated. In one case it amounted to nearly 3 grammes in twenty-four hours.—On the retention of irritability of certain organs separated from the body and immersed in an artificial nutritive medium, by MM. E. **Hédon** and C. **Fleig.**—The formation of callus, by MM. V. **Cornil** and P. **Coudray.**—Observations on the sea-level since historic and prehistoric times, by M. Ph. **Négris.** From the fact that two ancient piers at the south entrance of the Straits of Leucade are now nearly three metres under water, and from the encroachments of the sea in various parts of the Mediterranean during the last 2500 years, conclusions are drawn as to the change of level of the latter during a long period.—On the use of fluorescein in subterranean hydrology, by M. E. A. **Martel.**

CONTENTS.

PAGE

THURSDAY, AUGUST 6, 1903.

THE MINERAL WEALTH OF AFRICA.

Les Richesses Minérales de l'Afrique. By L. de Launay. Pp. 395; with 71 figures and maps. (Paris: Ch. Béranger, 1903.) Price 20 francs.

PROF. DE LAUNAY gives a further proof of his indefatigable industry in this new volume from his pen. It is a formidable task to deal even briefly with the mineral wealth of a huge continent, which has been only imperfectly explored; but fortunately the author is eminently qualified for the task. He is no novice in writing upon mineral deposits, and he has visited many mines in North Africa, besides the most important districts in the south. The book is arranged so as to suit two classes of readers, those who wish to learn all they can about the occurrence of some given mineral, such as gold, copper ore, phosphate of lime, &c., and those whose interest relates only to some particular country or region. This arrangement involves a certain amount of duplication, but it is certainly a convenience. Thanks are likewise due to the author for his little sketch maps. Who has not experienced the want of such maps? For when seated in an easy chair the reader is apt to be too lazy to get up and fetch his atlas, and he consequently often fails to derive full benefit from the work he is perusing.

What is the mineral wealth of South Africa? Of the future mineral resources of the Dark Continent we are ignorant; further explorations may reveal new treasures; but if by "mineral wealth" is understood the value of the present output, the question is answered by the following tables, which have been compiled from the Blue-books published annually by the Home Office. Though the information is necessarily incomplete, it will suffice for the purposes of the present article.

In a normal year, such as 1898, gold is seen to be far ahead of any other mineral as regards value; and when we consider that before the war with the Boers Africa was furnishing more than one quarter of the world's supply of the precious metal, it is evident that Prof. de Launay is fully justified in devoting his first chapter to a description of the auriferous deposits of the continent. The gold mines of the Witwatersrand naturally claim a full share of attention. Excellent figures, with full descriptions, explain the nature of the "banket" or gold-bearing conglomerate, and the question of the origin of the gold is discussed at some length. The three usual hypotheses are brought forward; they may be spoken of briefly as "previous origin," "contemporaneous origin," and "subsequent origin." In other words, it is supposed by some geologists that the gold is a detrital product, like the pebbles of quartz; others suggest that it was deposited from solutions while the pebbles were finding a resting place; whilst most mining engineers favour the idea that solutions brought it into the conglomerates long after their consolidation. The pros and cons are given in each case; however, there are difficulties in accepting any one of the three theories advanced, and Prof. de Launay honestly confesses that he is puzzled, and that he cannot make up his mind on the matter.

He is careful to point out that the Rand must be regarded as an exceptional case, and that it by no means follows from the discovery of "banket" in West Africa that the "Jungle" gold mines, as they are known on the Stock Exchange, will necessarily prove to be rich and valuable properties.

The pages relating to the occurrence of gold in Egypt contain matter of much antiquarian interest; the public are only now beginning to learn that Egypt was the California of the Old World, and that gold was being extracted from quartz veins between the Nile and the Red Sea at least 2500 years B.C. But the author makes a mistake in saying that the gold occurs under conditions similar to those under which it is found in *Cornwall*. In that county we have no auriferous deposits, for the small grains of the precious metal occasionally found in working stream tin in olden days were, practically speaking, mineralogical curiosities.

Next in importance come diamonds; for though the emeralds of Gebel Sabara and the turquoises of Sinai were known and worked by the ancients, the only gem-mining which need be taken into consideration at the present time is that of South Africa. It is a curious fact, on a continent in which both gold and gems were obtained in considerable quantities even in very remote ages, that the deposits which are now yielding so lavishly should have remained undiscovered until the latter part of the last century. The mode of occurrence of diamonds in South Africa is thoroughly well known to geologists; but the precise manner in which they were originally formed still affords room for speculation. Prof. de Launay repeats the hypothesis, already suggested in his previous work, "Les Diamants du Cap," that a bath of supercarburetted molten iron and magnesium existed beneath the granite, and that the diamonds were formed on a large scale after the fashion of the minute ones obtained artificially by Moissan.

The discovery of workable deposits of phosphate of lime is one of recent date; it now appears that they extend more or less continuously from Morocco to Egypt. Algeria already produces more than 300,000 tons a year, and Tunisia more than 200,000 tons from strata of Eocene age. The Egyptian deposits, which occur in Upper Cretaceous rocks, are extensive but poor.

There are reasons for believing that the dry Sahara and Algeria may contain deposits of nitrate of potash and nitrate of soda similar to the "caliche" of Chili; the matter is now being investigated officially.

Practically speaking, all the copper of Africa comes from Namaqualand; the advent of better means of transport may render this statement incorrect in the course of a few years, for ores of the metal are known to exist in many parts of the continent.

Coal of Permo-triassic age is worked in the Transvaal, Natal, and Cape Colony, and Rhodesia will soon become a producer.

The total value of all the minerals produced in

AFRICA.—*Output and Value of*

Mineral	Abyssinia Quantity Stat. Tons	Abyssinia Value £	Algeria Quantity Stat. Tons	Algeria Value £	Cape Colony Quantity Stat. Tons	Cape Colony Value £	French Soudan Quantity Stat. Tons	French Soudan Value £	German E. Africa Quantity Stat. Tons	German E. Africa Value £	Gold Coast Quantity Stat. Tons	Gold Coast Value £	Madagascar Quantity Stat. Tons	Madagascar Value £
Antimony Ore	—	—	136	883	—	—	—	—	—	—	—	—	—	—
Asbestos	—	—	—	—	149	2,037	—	—	—	—	—	—	—	—
Brown Coal	—	—	197	96	—	—	—	—	—	—	—	—	—	—
Clay	—	—	77,447	12,415	—	—	—	—	—	—	—	—	—	—
Coal	—	—	—	—	171,301	135,851	—	—	—	—	—	—	—	—
Copper Ore	—	—	—	—	36,822	310,636	—	—	—	—	—	—	—	—
Crocidolite	—	—	—	—	8	700	—	—	—	—	—	—	—	—
Diamonds (carats)	—	—	—	—	3,270,917 [carats	4,128,321	—	—	—	—	—	—	—	—
Fireclay	—	—	—	—	1,240	not stated	—	—	—	—	—	—	—	—
Flags	—	—	6,271	2,701	—	—	—	—	—	—	—	—	—	—
Garnets	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gold (ounces)	—	—	—	—	127 oz.	444	2,700 oz.	11,560	—	—	17,733 oz.	63,838	—	—
Gypsum	—	—	148	15	—	—	—	—	—	—	—	—	—	—
Iron ore	—	—	466,089	140,733	—	—	—	—	—	—	—	—	—	—
Lead Ore	—	—	118	624	—	—	—	—	—	—	—	—	—	—
Limestone	—	—	25,565	24,957	—	—	—	—	—	—	—	—	—	—
Marble	—	—	969	6,001	—	—	—	—	—	—	—	—	—	—
Onyx	—	—	216	2,497	—	—	—	—	—	—	—	—	—	—
Phosphate of Lime	—	—	265,145	215,600	—	—	—	—	—	—	—	—	—	—
Plaster	—	—	29,280	22,117	—	—	—	—	—	—	—	—	—	—
Potter's Clay	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Salt	—	—	20,966	17,193	11,850[1] 442,380 [bushels	32,598	—	—	—	—	—	—	—	—
Sand and Gravel	—	—	71,045	3,143	—	—	—	—	—	—	—	—	—	—
Silver Lead Ore	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Stone, Building	—	—	727,349	69,766	—	—	—	—	—	—	—	—	—	—
" Rough	—	—	674,663	37,843	—	—	—	—	—	—	—	—	—	—
Tin Ore	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Zinc Ore	—	—	29,304	56,268	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	612,852	—	4,610.587[3]	—	11,560	—	—	—	63.838	—	—

[1] Estimated at 60 lb. = 1 bushel.

[3] Total incomplete.

AFRICA.—*Output and Value of*

Mineral	Abyssinia Quantity Stat. Tons	Abyssinia Value £	Algeria Quantity Stat. Tons	Algeria Value £	Cape Colony Quantity Stat. Tons	Cape Colony Value £	French Soudan Quantity Stat. Tons	French Soudan Value £	German E. Africa Quantity Stat. Tons	German E. Africa Value £	Gold Coast Quantity Stat. Tons	Gold Coast Value £	Madagascar Quantity Stat. Tons	Madagascar Value £
Antimony Ore	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Asbestos	—	—	—	—	88	1,433	—	—	—	—	—	—	—	—
Brown Coal	—	—	210	102	—	—	—	—	—	—	—	—	—	—
Clay	—	—	117,312	17,040	—	—	—	—	—	—	—	—	—	—
Coal	—	—	—	—	205,810	180,413	—	—	—	—	—	—	—	—
Copper Ore	—	—	7,152	5,035	45,356	613,739	—	—	—	—	—	—	—	—
Crocidolite	—	—	—	—	3	150	—	—	—	—	—	—	—	—
Diamonds (carats)	—	—	—	—	2,781,385 [carats	5,387,955	—	—	—	—	—	—	—	—
Fireclay	—	—	—	—	900	not stated	—	—	—	—	—	—	—	—
Flags	—	—	8,218	3,424	—	—	—	—	—	—	—	—	—	—
Garnets	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gold (ounces)	31,161 oz.[1]	139,600	—	—	78 oz.	302	—	—	not stated	2,750	6,162 oz.	22,187	33,600 oz.	112,860
Gypsum	—	—	591	60	—	—	—	—	—	—	—	—	—	—
Iron Ore	—	—	506,347	198,679	—	—	—	—	—	—	—	—	—	—
Lead Ore	—	—	1,588	4,383	—	—	—	—	—	—	—	—	—	—
Limestone	—	—	26,574	25,500	—	—	—	—	—	—	—	—	—	—
Marble	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Onyx	—	—	289	3,352	—	—	—	—	—	—	—	—	—	—
Phosphate of Lime	—	—	260,815	212,000	—	—	—	—	—	—	—	—	—	—
Plaster	—	—	34,191	26,397	—	—	—	—	—	—	—	—	—	—
Potter's Clay	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Salt	—	—	18,226	15,995	not stated	not stated	—	—	—	—	—	—	—	—
Sand and Gravel	—	—	85,357	3,774	—	—	—	—	—	—	—	—	—	—
Silver Lead Ore	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Stone, Building	—	—	785,948	73,744	—	—	—	—	—	—	—	—	—	—
" Rough	—	—	1,413,566	56,550	—	—	—	—	—	—	—	—	—	—
Tin Ore	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Zinc Ore	—	—	26,488	52,704	—	—	—	—	—	—	—	—	—	—
Total	—	139,600	—	698,739	—	6,183,992[5]	—	—	—	2,750	—	22,187	—	112,860

[1] 2,710 ounces of fine silver are contained in the gold.
[5] Total incomplete.

Minerals in the year 1898.

Natal		Orange River Coly.		Portug. E. Africa		Rhodesia		Senegal		Transvaal		Tunis		Total	
Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £
—	—	—	—	—	—	—	—	—	—	—	—	—	—	136	833
—	—	—	—	—	—	—	—	—	—	—	—	—	—	149	2,037
—	—	—	—	—	—	—	—	—	—	—	—	—	—	197	96
—	—	—	—	—	—	—	—	—	—	—	—	—	—	77,447	12,415
387,811	75,015	—	—	—	—	—	—	—	—	1,907,809	668,346	—	—	2,466,921	879 212
—	—	—	—	—	—	—	—	—	—	—	—	—	—	36,822	310,636
—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	700
—	—	288,937 [carats	498.797	—	—	—	—	—	—	22,843 [carats	43,730	—	—	3,582,697 [carats	4,670,848
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1,240	not stated
—	—	—	—	—	—	—	—	—	—	—	—	—	—	6,271	2,701
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17 oz.	60	—	—	—	—	22,911 oz.	83.053 [2]	4,147 oz.	15,464	3,830,337 [oz.	16,240,630	—	—	3,877,972 oz	16,415,049
—	—	—	—	—	—	—	—	—	—	—	—	10,629	not stated	10,777	15
—	—	—	—	—	—	—	—	—	—	—	—	—	—	466,089	140,733
—	—	—	—	—	—	—	—	—	—	—	—	2,337	7,536	2,455	8,160
—	—	—	—	—	—	—	—	—	—	—	—	—	—	25,565	24,957
—	—	—	—	—	—	—	—	—	—	—	—	591	not stated	1,560	6,001
—	—	—	—	—	—	—	—	—	—	—	—	—	—	216	2,497
—	—	—	—	—	—	—	—	—	—	—	—	—	—	265,145	215,600
—	—	—	—	—	—	—	—	—	—	—	—	—	—	29.280	22,117
—	—	—	—	—	—	—	—	—	—	—	—	5,708	not stated	5.708	not stated
—	—	—	—	—	—	—	—	—	—	—	—	7,185	6,424	40,001	56,215
—	—	—	—	—	—	—	—	—	—	—	—	—	—	71,045	3,143
—	—	—	—	—	—	—	—	—	—	80	500	—	—	80	500
—	—	—	—	—	—	—	—	—	—	—	—	290.341	not stated	1,017,690	69,766
—	—	—	—	—	—	—	—	—	—	—	—	65,942	not stated	740,605	37,843
—	—	—	—	—	—	—	—	—	—	23	1,800	—	—	23	1.800
—	—	—	—	—	—	—	—	—	—	—	—	21,419	43.268	50,723	99,536
—	75.075	—	498.797	—	—	—	83,053	—	15.464	—	16,955,006	—	57,228[3]	—	22,983,460

[2] This total is made up of gold declared to August 31, 1898, viz., 6,533 oz., and gold produced from September to December, 1898, 16,378 oz.

Minerals in the year 1901.

Natal		Orange River Coly.		Portug. E Africa		Rhodesia		Senegal		Transvaal		Tunis		Total	
Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £	Quantity Stat. Tons	Value £
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	88	1,433
—	—	—	—	—	—	—	—	—	—	—	—	—	—	210	102
—	—	—	—	—	—	—	—	—	—	—	—	—	—	117,312	17,040
569 200	549.439	—	—	—	—	—	—	—	—	468,162 [2]	201,634	—	—	1,243,179	931,486
—	—	—	—	—	—	—	—	—	—	—	—	—	—	52,508	618,774
—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	150
—	—	—[4]	—	—	—	—	—	—	—	—	—	—	—	2,781,385 [carats	5,387,955
—	—	—	—	—	—	—	—	—	—	—	—	—	—	900	not stated
—	—	—	—	—	—	—	—	—	—	—	—	—	—	8,218	3,424
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2,750
135 oz.	531	—	—	13,632 oz.	52,577	172,035 oz.	623,627	—	—	230,801 [3] [oz.	980,381	—	—	487,604 oz.	1,932,065
—	—	—	—	—	—	—	—	—	—	—	—	—	—	591	60
—	—	—	—	—	—	—	—	—	—	—	—	—	—	506,347	198,679
—	—	—	—	—	—	—	—	—	—	—	—	8,070	26,760	9 658	31,143
—	—	—	—	—	—	—	—	—	—	—	—	34,250	29,635	60,824	55,135
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	289	3,352
—	—	—	—	—	—	—	—	—	—	—	—	169,653	105,700	430,468	317,700
—	—	—	—	—	—	—	—	—	—	—	—	12,779	24,078	46,970	50,475
—	—	—	—	—	—	—	—	—	—	—	—	6,274	300	6,274	300
—	—	—	—	—	—	—	—	—	—	—	—	16,633	14,880	34,850	30,875
—	—	—	—	—	—	—	—	—	—	—	—	—	—	85,357	3,774
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	860,004	61,251	1,645,952	134,995
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1,413,566	56,550
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	17,617	43,240	44,105	95,944
	549,970	—	—	—	52,577	—	623,627	—	—	—	1,182,015	—	305,844	—	9,874,161

[2] Output for the last four months of the year only. [3] Output for the last six months of the year only.
[4] No work was done at the Jagersfontein Mine during the financial year ended March 31, 1902. The output for the financial year ended March 31, 1901, was 18,002 carats, valued at 37,079*l*.

Africa in 1898 was about 23 millions sterling. This amount seems small for the huge continent, when we reflect that in 1901 the coal output of Wales alone was worth 19½ millions, and that of Northumberland and Durham about the same amount. But after reading Prof. de Launay's book, it needs no prophet to predict that Africa's mineral deposits will soon be more largely utilised.

ROWLAND'S WORK.

The Physical Papers of Henry Augustus Rowland. Collected for publication by a Committee of the University. Pp. xi + 704. (Baltimore: Johns Hopkins University Press; London: Wesley and Son, 1902.) Price 30s. 6*d.* net.

PROF. ROWLAND'S friends have been well-advised in issuing as a memorial to their late colleague this volume of his collected papers. It enables us to realise more fully all we owe to him and to grasp the value and importance of his work.

Commencing with an early note sent to the *Scientific American* when the author was seventeen, the list of scientific papers concludes with an article on diffraction gratings, published in the new edition of the "Encyclopædia Britannica" after Rowland's death. Then there follow some six addresses on scientific subjects, a bibliography, and an account of the dividing engines he designed.

Dr. Mendenhall's commemorative address, delivered shortly after Rowland's death, fitly forms an introduction to the whole, and gives us a glimpse of his life and methods of work.

Rowland's fame came to him early, though not without some severe struggles and disappointments on his part, and it is a satisfaction to us Englishmen to know that it was Maxwell who first recognised his genius. Prof. Mendenhall tells again the story of his first serious paper, "On Magnetic Permeability and the Maximum of Magnetism of Iron, Steel, and Nickel," *Phil. Mag.*, 1873. The paper was more than once rejected in America because it was not understood, and finally it was sent to Maxwell, who wrote immediately that since the temporary suspension of their meetings made it impossible to communicate the paper to the Royal Society, he would send it to the *Philosophical Magazine*, where it appeared in August, 1873, Maxwell having himself, to save time, corrected the proofs. In this paper Rowland introduced the idea of the magnetic circuit as the analogue of Ohm's law, and developed the now well-known ring method of measuring permeability. In 1875, on his appointment as first professor of physics at the Johns Hopkins University, he came to Europe and worked for a time in Helmholtz's laboratory at Berlin, and by his researches answered Tait's question, put to Maxwell in these words—

Will mounted ebonite disc
  On smooth unyielding bearing,
When turned about with motion brisk
  Nor excitation sparing,
Affect the primitive repose
  Of + and − in a wire?

To which Maxwell replies—

The mounted disc of ebonite
  Has whirled before nor whirled in vain,
Rowland of Troy that doughty knight
  Convection currents did obtain
In such a disc of power to wheedle
  From its loved North the subtle needle.

And Maxwell goes on to explain that such convection currents will not produce electromotive force in a neighbouring wire unless the speed of the disc were variable.

The paper on the "Magnetic Effect of Electric Convection," No. 12, in the volume before us, was presented in the *American Journal of Science* for 1878; von Helmholtz had already announced the result to the Berlin Academy in 1876. Rowland returned to the problem with the same result in 1889, in a paper presented in the *Philosophical Magazine*, No. 43 of his collected works. As is well known, the results were challenged by Crémieu shortly before Rowland's death. Many readers of NATURE will remember the interesting occasion in Section A of the British Association at Glasgow, when Crémieu described how he had failed to obtain the effect. Those present felt that in view of the confirmation of Rowland's results obtained at Baltimore by Pender, Crémieu must have been misled, but no one could put his fingers definitely on the error. It is satisfactory to know, from the recently published joint work of Crémieu and Pender, that Rowland was right, and that a convection current of electricity does produce a magnetic field.

The research into the value of the British Association unit of resistance, No. 15, and a determination of the value of "*v*," No. 44, complete the series of fundamental electrical researches, though his collected papers contain many other memoirs of real importance.

In his experiments on the absolute unit of resistance, Rowland shows his usual acumen as a critic and skill as a mechanic and observer. Various lines of argument had shown that the B.A. unit, supposed to represent 10^9 C.G.S. units of resistance, was in error. Rowland sums up effectively his criticisms on the method of the B.A. committee and points out the sources of error in Weber's method by damping adopted by Kohlrausch. He then describes his own method, a modification of that originally proposed by Kirchhoff, and, after a careful account of his apparatus and measurements, arrives at the result 1 B.A. unit$=0.9911\times10^9$ C.G.S. units. A repetition of his experiments in 1884 gave 0.98627, while about the same time his pupil, Kimball, using Lorenz's method, arrived at the result 0.9864. The value obtained at the Cavendish Laboratory was 0.9867.

Part iii. of the collected papers deals with the work on Heat, and foremost among these is the great memoir on the "Mechanical Equivalent of Heat," a work which, if it stood alone, would have made Rowland's name as the foremost physicist of his nation.

The refinements of modern thermometry have enabled us to introduce some small corrections into certain of the results, but the work remains unrivalled.

Rowland was an engineer, and this stood him in good stead in all his researches, and nowhere more so than in the paper under consideration.

In arranging his laboratory, Prof. Mendenhall tells us, many of his friends thought he was giving undue prominence to the workshop, its machinery and tools, and to the men to be employed in it, but he planned wisely, for in original work "a well-manned and equipped workshop is worth more than a storehouse of apparatus already designed and used by others."

So, too, it was in the optical work described in part iv.; the concave grating is the child of the perfect screw, and he who would make a perfect screw must follow Rowland as he described his method in the article, "Screw," "Encyclopædia Britannica," ninth edition, No. 33 of the Collected Papers.

The secret is to correct the screw by grinding it in a long adjustable nut longer than the screw itself; thus, if the finished screw is to be 9 inches long, the nut should be 11 inches; as the grinding progresses the nut is closed in, and the grinding continues for two weeks, the nut being turned end for end every ten minutes and the screw kept in water constant in temperature to within 1° C. all the time.

It is not strange that machines which can rule gratings are rare.

The original paper on "Concave Gratings," No. 29, is a short one, but valuable details are given in No. 49, "Gratings in Theory and Practice," and in the "Encyclopædia" article already referred to.

The addresses which fill the last hundred pages of the book are full of interest. To many who have followed the accounts recently given in the pages of NATURE of the wealth and endowments of American universities, "A Plea for Pure Science" will appeal forcibly. Rowland was not satisfied that even America was doing all that was needed.

"The whole universe is before us to study. The greatest labour of the greatest minds has only given us a few pearls, and yet the limitless ocean, with its hidden depths filled with diamonds and precious stones, is before us. The problem of the universe is yet unsolved, and the mystery involved in one single atom yet eludes us. The field of research only opens wider and wider as we advance, and our minds are lost in wonder and astonishment at the grandeur and beauty unfolded before us. Shall we help in this grand work or shall we not? Shall our country do its share or shall it still live in the almshouse of the world?"

Or, again, in his last address, "On the Highest Aim of the Physicist," note his words, after speaking of the work of the Physician:—

"The aims of the physicist, however, are in part purely intellectual; he strives to understand the universe on account of the intellectual pleasure derived from the pursuit, but he is upheld in it by the knowledge that the study of nature's secrets is the ordained method by which the greatest good and happiness shall finally come to the human race."

Rowland unlocked some of the hidden chambers himself; he did more than this, he put into our hands the machine by which we may hope to forge the key which will open the door leading to some of the innermost recesses.

R. T. G.

A VINE DISEASE.

Annales de l'Institut Central Ampélologique Royal Hongrois. Tome ii. Pp. vii+288+plates. (Budapest: Société d'Imprimerie et d'Editions Pallas, 1902.)

THIS admirably printed volume is devoted entirely to an exhaustive study of the *Rot livide* of the vine, a destructive disease due to the ravages of a minute fungus known to botanists as *Coniothyrium Diplodiella*. The memoir reflects credit on the author, Dr. Istvánffi, not only on account of the thoroughness and clearness of the 288 pp. of text, but also from the beauty and completeness of the numerous (215) excellent figures set forth on the 24 plates.

Of the fifteen chapters into which the work is divided, the first deals with the somewhat extensive history of this now almost ubiquitous malady, the place of origin of which is not known with certainty, but which appears to have been more probably south-eastern Europe than the America to which we owe so many pests.

Chapters ii.–iv. are concerned with the description of the rot as manifested on the shoots and leaves of both native and American vines grown in Europe, and the pathological alterations induced in the tissues by the parasite.

The principal signs when the disease is advanced are brown spots and patches on the leaves, in the dead tissues of which the minute black pycnidia appear; the cortex shrivels, turns brown, and peels in fibrous masses as it dries. The dead twigs also show that the pith is destroyed, and similar pycnidia—frequently accompanied by other fungi such as Botrytis, Pestalozzia, Colletotrichum, &c.—appear on the surface. The dead twigs easily disarticulate at the nodes, and the leaves above, even if not directly attacked, shrivel and die because the diseased internodes cannot supply them with water. A characteristic chambering of the dying pith often precedes its total destruction, and may remain visible at the nodes long after the pith of the internodes has dried up.

Microscopic examination shows that the hyphæ of the fungus causing these destructive effects permeate all the softer tissues, and rapidly destroy the cortical parenchyma with the formation of large gaps filled with mycelium, and an interesting struggle for the mastery between fungus and host is evinced as the medullary rays, parenchyma and cambium attempt to heal up the wounds already made; in vain, however, and the hyphæ pass from cortex to pith *viâ* these medullary rays.

It is, of course, impossible to enter here into the numerous microscopic details, which, as might be expected from so able a histologist as Dr. Istvánffi, are very thoroughly done, and embrace many discoveries of interest, such as the sugar sphærocrystals in certain cells of the diseased cortex, the curious, cambium-like callogene layer, &c. Every botanist will find the careful microchemical reactions valuable, and the coloured diagrams of the behaviour of the diseased tissues are particularly instructive.

But it is not only the stems and leaves that are invaded by this fungus; it also attacks the grapes

themselves, either *viâ* the pedicels or from outside, and the author gives an instructive set of figures illustrating the development of the flower and young fruit in connection with chapter v.

Chapter vi. is concerned with the development of the fungus in the different organs of the vine, and with descriptions and figures of its numerous reproductive phases, comprising two forms of conidia, two forms of pycnidia, the perithecia, and certain sclerotium-like stages.

In chapter vii. the results of pure cultures are described, and the conclusion established that the spores may germinate in rain-water, and the young mycelium suffer desiccation, and again revive if wetted; further, that spores germinating on the surface of the plant may remain alive and active for as much as six days in damp weather, awaiting a moment favourable for infection, as it were. Dry spores may be kept twenty-three months, and still germinate on placing in water. The numerous morphological details must be passed over here.

In chapter viii. the various modes of infection are dealt with, and the results are that the fungus may enter by the pedicel, by the peduncle or one of its branches, or at the articulation of the fruit to its stalk, or it may enter the fruit directly. A valuable series of coloured figures shows the various tints assumed by the diseased grapes, and we are reminded of one form of the disease termed "shanking" in this country.

Chapter ix. is devoted to the experimental infections. Many points of interest are given here, *e.g.*, the tips of the germ-tubes directly dissolve the cuticle; a cellulose dissolving enzyme also occurs; liquefied walls resist attack, &c.

Chapters x. to xii. deal very thoroughly with treatment, and the numerous experiments show that calcium bisulphite and free sulphurous acid are practically the only efficacious remedies, Bordeaux mixture and other copper compounds, or mixtures, as well as several other media being found useless.

In chapter xiii. an account is given of the various other fungi which may accompany the Coniothyrium.

Chapter xiv. is devoted to a discussion of the systematic position of the fungus, while chapter xv., and last, again returns to the question of treatment, this time dealing with it in the form of advice as to methods, quantities, periods, &c.

There can be no question that Istvánffi's memoir has a three-fold importance, (1) to the vegetable pathologist, owing to the clear and exhaustive account of the parasite and its relations to the host; (2) to the histologist and morphologist, because it contains so many interesting anatomical details concerning the host and its parasite, and (3) to the practical vine-grower, who will get from it one of the best accounts of symptoms and treatment we have ever met with.

The scientific value of Istvánffi's book is undoubtedly dependent on his clear recognition of the fact that, to deal properly with any parasitic disease, it is essential to take into account not only the peculiarities of the fungus, but also the reactions of the host-plant.

The one great fault we have to find with it is the want of summaries to the several chapters and to the whole work.

OUR BOOK SHELF.

Kinematics of Machines. By R. J. Durley, B.Sc., Ma.E. Pp. viii + 379. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 17s. net.

THIS is a carefully written elementary text-book dealing with the subject from the Reuleaux standpoint. In the first chapter the author introduces the notions of kinematic links and chains and the pairing of elements, and gives some fundamental propositions relating to degrees of freedom and constraint, and to instantaneous centres and centrodes in plane motion.

The next chapter treats pretty fully of motion in a straight line and about a fixed axis. Position, velocity and acceleration, linear and angular, in regard to both time and displacement, are exhibited by means of rectangular and polar diagrams, and problems are worked by graphical processes, the scales for measuring the results being always most carefully determined. The alternative, and often more desirable method of tabulation and the numerical calculation of differences seems to have been overlooked; it might well have been introduced and illustrated in an example like that of the electric car found on p. 47. Several problems on simple harmonic motion are given; but the author is scarcely alive to the great and growing importance of this branch of the subject. The fruitful idea of a rotating vector is not fully taken advantage of. A few additional pages are all that would be required in order to show how, in many cases of periodic motion, being given or having plotted a number of suitable positions in the cycle, the motion could be quite easily analysed and expressed approximately in the first three or four terms of the Fourier series, and thus readily comprehended and dealt with.

In the next two chapters the various mechanisms contained in the quadric and slider crank chains are well described and excellently illustrated. In all the more important cases the relations between the linear and angular velocities and accelerators are obtained both graphically and analytically, the principles established in the first two chapters being now applied.

Chapter v. is interesting, being an investigation of the motion in plane mechanisms in general. The author establishes and uses the velocity and acceleration images of Prof. R. H. Smith. As an example it is shown how to find the velocity of any point in a Stephenson link. The direct and powerful method of working from point paths is also illustrated, but is deprecated on account of its supposed inaccuracy. We, however, have found that, by the use of suitable appliances, large scale plotting can be carried out expeditiously, and with a degree of precision which render it possible to obtain not only velocities, but accelerations (or second differences), with quite surprising accuracy, and sufficient for most purposes.

Subsequent chapters relate to mechanisms containing higher pairing and non-rigid links, illustrated by spur gearing, cams, ratchets, escapements, belt and chain gearing, springs, chamber trains, &c. And there are chapters on screw and spheric motions, the latter containing an instructive investigation of the rolling and spinning velocities in various types of ball-bearings. The book concludes with a short historical account of the attempts which have been made to classify mechanisms.

The rigid exclusion of kinetics and of all dynamical considerations from a book like the present seems artificial, and to restrict its value; but those who do not take this view, and who follow Reuleaux, will welcome the volume. The descriptions are clear, the illustrations well selected, and the diagrams beautifully executed. Graphical and analytical calculations are judiciously mixed without an undue use of either.

Determination of Radicles in Carbon Compounds. By Dr. H. Meyer. Translated by J. Bishop Tingle, Ph.D. Pp. xii + 162. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 4*s.* 6*d.* net.

DR. MEYER has brought out a book of considerable value to chemists engaged in research work; it is hardly a book for students, unless working along research lines. Such a work as this is very difficult to criticise, because it is really a small dictionary of methods; such dictionaries are naturally very useful, provided they are carefully drawn up, which we consider to be the case in the book before us. Take, for example, the first chapter, which consists of 37 pp., and includes practically all the methods which may be used for determining the hydroxy-groups. One might be inclined to think this rather an unnecessary amount of space to devote to such an apparently simple matter as the determination of the $-OH$ radicle, but as there is very little padding, it really points out that in organic chemistry conditions govern everything; that a method which, under certain conditions, may be applied with success is quite useless when these conditions are altered or modified.

In the next chapter we have the determination of the methoxy- and ethoxy-groups by means of Zeisel's method. Three diagrams of complicated pieces of apparatus are given for the carrying out of this important determination. It is a pity, considering both the author and translator have evidently taken considerable trouble to bring the book up to date, and the importance of the method, that they missed Hewitt's simple modification described in the *Journal* of the Chemical Society for 1902; this is probably an oversight, because at another place they give a reference from the same journal.

Under the determination of the carboxyl groups, the method by means of the electrolytic conductivity of the sodium salts is described. It is doubtful, however, whether the description will be of much value to anyone who has not previously carried out such a determination. Not that this matters very much, because in a foot-note a reference to Ostwald's work is given, where a description of the parts of the apparatus may be found.

Dr. Meyer has evidently taken great pains in preparing this book, and has considerably added to its value by the copious references to original literature which he has added. For the rest the translator and publisher have carried out their part of the work with discretion and care. F. M. P.

A Laboratory Guide for Beginners in Zoology. By Clarence Moores Weed, D.Sc., and Ralph Wallace Crossman, B.A., M.Sc. Pp. xxiv + 105. (London: D. C. Heath and Co., 1903.) Price 2*s.* 6*d.*

THIS handy and very moderately priced laboratory guide will be useful in those courses of elementary instruction in zoology which aim at a fairly wide survey of the types of animal life without going into great detail in regard to any. Thus there are instructions in regard to six Protozoa, two sponges, three Hydrozoa, a rotifer, three Echinoderms, the earthworm and Nereis, Cyclops, the wood-louse, the lobster, the crab, the centipede, three insects and a spider, three molluscs and three vertebrates, altogether thirty-two types. The directions for study are for the most part really directions, and not little paragraphs of condensed information; many of them take the form of questions. The student is not supplied with ready-made diagrams; he is asked precisely to draw certain things. There is a directness and business-like clearness about the whole book that we like, and its partiality is frankly admitted, supplementary text-books being indicated. It would have been well if the authors had always stated what particular species they had in view, *e.g.* what Tubularian and Campanularian hydroid or hydroids. In some cases the headings do not read very happily, if the book is to be used in Britain, *e.g.* "The simple Marine Sponge (Grantia sp.). This sponge is a marine animal, found commonly along the Atlantic coast of the United States." But we can recommend the little book as a terse, unpretentious, and clear guide to introductory studies of the structure of animals.

A Manual of Drawing. By C. E. Coolidge. Pp. iv + 200 (alternate pages blank). (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1902.) Price 1 dollar.

THE drawings and designs made by the professional draughtsman in a good manufacturing workshop are characterised by a style and completeness which easily distinguishes them from the amateur productions commonly met with in the technical school and college. The object of the author in this book is to give to students precise and minute instructions relating to the numerous small details of manipulation and drafting that must be followed if drawings are to be such as would command respect in a commercial establishment.

Thus we find information about drawing and tracing papers, black and coloured inks, printing processes, drawing boards and squares, compasses, scales and protractors, indiarubber, drawing pens and pencils, and, in fact, about drawing tools and implements in general. Instruction is given as to the proper way of arranging the several views in a drawing, of inserting the dimensions, printing the titles, &c. Various types of drawing are described, including detail sheets fully dimensioned, with the machining and materials specified; general views, with only leading features exhibited; patent office drawings made in conformity with the United States' regulations, and suitable for photographic reproduction, &c.

The student is assumed to have obtained elsewhere a practical knowledge of workshop processes, of machine construction, and of the forms and proportions of machine parts. The author gives that kind of information which would be gradually acquired, almost unconsciously, by any one working alongside an expert in a commercial drawing office. The book contains a useful index and a number of plates in illustration of the text. Alternate pages are left blank in order to induce and enable the student to collect and record additional notes and observations of his own, or which his instructor may impart.

Zoologische Wandtafeln. Gezeichnet und herausgegeben von Prof. Dr. Paul Pfurtscheller, Wien. (Wien und Leipzig: A. Pichler's Witwe und Sohn.)

THIS is a new series of large wall diagrams for lecture-rooms, similar to those which we owe to Leuckart and Nitsche. The two samples we have seen—of the sea-urchin and the snail—command our admiration, especially the former. They are boldly and clearly drawn, with more shading than colour, and they stand out admirably from a distance. Two of those on the sea-urchin sheet are even beautiful. Our only criticism is that it seems a mistake to mix up *mere* diagrams, *e.g.* two simple figures on the snail sheet, with the chief picture, which shows things more or less as they are. The mere diagram can be drawn on the blackboard in a minute, and should not be put on the same plane as the elaborate drawing of the half-opened sea-urchin, which the teacher requires as a permanent part of his illustration equipment.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Radium and Cancer.

IT has occurred to me that perhaps you would care to publish the enclosed letters, and thus start some one experimenting with the radium rays in the manner suggested.

Dr. Sowers is a distinguished physician of Washington, D.C., now spending a portion of his summer vacation in Baddeck, Nova Scotia.

ALEXANDER GRAHAM BELL.

Baddeck, N.S., July 21.

Dr. Z. T. Sowers,
1707 Massachusetts Avenue,
Washington, D.C.

Dear Dr. Sowers,

I understand from you that the Röntgen X-rays, and the rays emitted by radium, have been found to have a marked curative effect upon external cancers, but that the effects upon deep seated cancers have not thus far proved satisfactory.

It has occurred to me that one reason for the unsatisfactory nature of these latter experiments arises from the fact that the rays have been applied externally, thus having to pass through healthy tissues of various depths in order to reach the cancerous matter.

The Crookes's tube from which the Röntgen rays are emitted is, of course, too bulky to be admitted into the middle of a mass of cancer, but there is no reason why a tiny fragment of radium sealed up in a fine glass tube should not be inserted into the very heart of the cancer, thus acting directly upon the diseased material. Would it not be worth while making experiments along this line?

Yours sincerely,
(Signed) ALEXANDER GRAHAM BELL.

Baddeck, N.S., July 21.

Dr. A. Graham Bell,
Baddeck, N.S,

Dear Dr. Bell,

The suggestion which you make in regard to the application of the radium rays to the substance of deep seated cancer I regard as very valuable. If such experiments should be made, I have no doubt they would prove successful in many cases where we now have failures.

Yours sincerely,
(Signed) Z. T. SOWERS, M.D.

Baddeck, N.S., July 21.

The American Tariff and the St. Louis Exhibition.

As a member of the Royal Commission appointed to make a success of the British Section of the St. Louis Exhibition, I have, in common with some of my colleagues, been met by the difficulty, which for a time seemed an insuperable one, that our manufacturers could not be prevailed upon to send their goods to this exhibition, even though they would be admitted duty free, because the tariff had practically killed their trade with the country.

Even in the subject in which I am interested, instruments of precision, I have been met with this answer to such an extent that for a time I feared that the formation of a representative collective exhibit would be impossible.

I wish, if you will afford me the space, to point out to our manufacturers that in our class the incidence of the duty need not be so disastrous to trade as it must be in many others. Not only will instruments and other goods sold from the exhibition to public institutions in the United States be allowed to be sold free of duty, but instruments and other goods sold to public institutions in the United States from this country are also admitted free of duty. (See extract from Tariff Law below.)

As in the case of instruments of the highest class the requirements of public institutions are necessarily large in comparison with the demands of the public, more especially, I believe, in a country like the United States, where institutions of this kind are so liberally supported, and as this disparity is probably greater in the case of goods in this class than in any other, I hope you will enable me through your columns to urge our makers to reconsider any refusal to assist the Royal Commission in the formation of an adequate collective exhibit that may have been made on these grounds, and to avail themselves of such advantages as we are able to offer.

Section 638 of the Tariff Law of 1897 provides as follows:—

"638. Philosophical and scientific apparatus, utensils, instruments and preparations, including bottles and boxes containing the same, specially imported in good faith for the use and by order of any society or institution incorporated or established, solely for religious, philosophical, educational, scientific or literary purposes, or for the encouragement of the fine arts, or for the use or by order of any college, academy, school, or seminary of learning in the United States, or any State or public library, and not for sale, subject to such regulations as the Secretary of the Treasury shall prescribe."

It should be noted, however, that surgical instruments are not classified as philosophical or scientific.

C. V. BOYS.

The Eucalypts.

YOUR reviewer of two recent works on Eucalypts (April 2, p. 524) seems to require correction on certain points. *Eucalyptus globulus* cannot be considered as the first in economic importance amongst the Eucalypts. In almost every shade of extra-tropical climate there is to be found a Eucalypt which will grow as well, or better, than *E. globulus*, and yield a far superior timber. It is generally held now that Eucalypt planting has suffered by the indiscriminate praise showered on *E. globulus* by the early Eucalypt enthusiasts.

Your reviewer says, further, that Eucalypt plantations now exist in Italy, France, Algeria, California, and other countries. He does not appear to be aware that there is probably more Eucalypt plantation in South Africa than in any other country, and that at the present rate of progress there will, in a few years, be more Eucalypt plantations in South Africa than in all the other countries combined. There is no group of trees in the warm temperate regions of the world that can produce hardwoods of good quality so rapidly and so cheaply as Eucalypts, and their cultivation bids fair to become the central factor in the forestry of these regions. At this moment train-loads of Eucalypt timber are pouring into South Africa, Eucalypt sleepers displacing metal and creosoted-pine sleepers. South Africa will soon be paying out something like a *quarter of a million pounds yearly* for Eucalypt timber imported for railway sleepers and mining timber (little or none of this, by the way, *E. globulus*), so that any delay in the prosecution of Eucalypt planting in South Africa would be a most expensive proceeding. It is noteworthy that, so long as the Eucalypt is properly fitted to its climate, it seems to grow better in South Africa than in Australia, the explanation being probably that all the Eucalypts in South Africa have been raised from seed, and are thus growing in South Africa free from their Australian pests, both fungoid and insect. With the view of preserving this happy immunity from disease, the importation of Eucalypt plants into Cape Colony is placed under stringent restrictions.

The meritorious work of Messrs. R. T. Baker and H. G. Smith, if carried to a conclusion, should be the classic for many years on Eucalyptus oil. Your reviewer is mistaken in saying that practically all the Eucalypt species indigenous to Australia are included in their work. Practically, all the Eucalypts are indigenous to Australia, but they are not included in Messrs. Baker and Smith's work, which em-

braces 111 out of 120 described species of New South Wales and a few others from the neighbouring colonies of East Australia, but none of the well-known timber Eucalypts of Western Australia, Jarrah, Kari, Touart, red gum, York gum, &c.

It is a little disappointing that the authors were unable to obtain leaves of such a prominent Eucalypt as *Eucalyptus regnans*, the tree which shares with *E. diversicolor* the honour of being the tallest tree in the world. It is common enough in the Government plantations near Cape Town, as is also *E. alpina*, which figures also in the list of unprocurables. It is particularly unfortunate that they have not tested *Eucalyptus calophylla*, the type of the parallel veined Eucalypts. This is a West Australian species.

Messrs. Baker and Smith state that forty tons of Eucalypt leaves were used and 500 distillations made. Their work is a model of painstaking investigation, and to the chemist and those interested in the oil industry will no doubt prove extremely useful.

But the authors have not confined themselves to the chemistry of Eucalyptus oil. They propose a number of new Eucalypt species and a new classification of Eucalypts. How far the numerous new species will stand the test of critical investigation in the field remains to be seen. Many of their new species have already been contested.

Messrs. Baker and Smith have discovered that there is a relation between the venation of Eucalypt leaves and the chemical constitution of the oils of those leaves. Parallel veins and pinene go together. Many of the parallel veined leaves smell of turpentine like a pine leaf. Then come the peppermint Eucalypts, containing piperitone, with a more complex venation; and then a still more complex venation yielding oils rich in eucalyptol or cineol, which is the valuable constituent in the best Eucalypt oils. This is a very interesting and important correlation, especially if further investigation shows that it holds good through the whole Eucalypt genus. As chemists, one can pardon the authors their enthusiasm over it. But whether it is sufficient to found a new classification of Eucalypts on may be doubted. We have numerous Eucalypt classifications in the field. There is that which is generally accepted in default of a better, the anthereal system of Bentham, somewhat modified and simplified, but not improved in Mueller's subsequent works. There is a (perhaps more practical) bark system, and there are various obsolete systems founded on the shape of the cones and the flower buds. As Messrs. Baker and Smith most justly remark, a natural classification founded on a combination of all these, including the quality and structure of the timber, has yet to be made. It is not likely that their oil-and-vein classification will be sufficient in itself. It seems unlikely that anyone, except a scientifically trained forester, who has spent a large portion of his life among the Eucalypts in their natural forests, will be able to construct a sound natural grouping of the species of this difficult genus. The work will require a Mathieu, a Brandis, or a Gamble, that is to say, a practical forester with special scientific qualifications. It is not to be done with botanical specimens as Bentham and Mueller attempted it, nor with practical knowledge alone as Wools attempted it, nor in a chemical laboratory where Messrs. Baker and Smith have done most of their work! It is true that Mr. Maiden is now bringing out a "Critical Revision of the Genus Eucalyptus," and from this, with his great reputation as a practical botanist, much is expected. The first number, on that very important species *Eucalyptus pilularis* and its allies, has already appeared, also part ii. on *E. obliqua* and the gum-top stringy barks.

In view of the differences in the quality of the oil yielded by various Eucalypts, the authors advocate plantations in certain circumstances of good oil-yielding species. The lopping they suggest a forester would replace by coppicing. It is believed that all Eucalypts coppice well. Most of them will stand a considerable amount of lopping, but it eventually kills them. It is only in a few instances that species of Eucalyptus are found predominating over an area of country to any great extent, so that a particular species being worked for its oil may soon be cut out in close proximity to a permanent plant. But some Eucalypts are very tenacious of life, and "suckers" soon spring from the stumps of the trees cut down; it is thus only a matter of a few years when fresh material is again obtainable. This may be seen from the photograph of *E. Smithii*, where most of the dense growth is from "suckers" of this nature. We have been able to show, in several instances, that the oil obtainable from this young growth is of the same character as that obtained from the mature leaves, so that no great differences in the quality of the oil need be expected. But we think it to be a pity that the trees should, in many instances, be felled for their leaves alone. By judicious lopping a fresh supply of leaves could more quickly be obtained, so that a permanent supply might be assured. There are a few species of Eucalyptus, however, which form the prevailing vegetation in certain localities, and are found growing gregariously in their native habitat; this is particularly the case with some of the "Mallees." In New South Wales there are several species of this nature, as, for instance, the "Blue Mallee," *E. polybractea*; the "Red" or "Water Mallee," *E. oleosa*; the "Grey Mallee," *E. Morrisii*; and the "Argyle apple," *E. cinerea*; all these species give good eucalyptol oils, and all are more or less gregarious in their habits, so that natural plantations of these species are practically ready to hand; but besides these naturally covered areas the question of the cultivation of certain Eucalyptus species is of importance in this connection.

It may possibly be accepted as conclusive that some Eucalyptus species are not inexhaustible under certain conditions, and it is worthy of consideration whether plantations of young trees of *Eucalyptus Macarthuri*, for instance, might not be profitably cultivated for the preparation of its valuable geranyl-acetate oil. So with the eucalyptol oils, it is probable that the cultivation of some species, *E. Smithii*, for instance, could be profitably undertaken, and from which young growth an oil could be distilled that would compete satisfactorily, both in price and eucalyptol content, with any European oil of this class.

A minor fault running all through their book is their use of the word "sucker." By "sucker" is properly understood shoots from the roots, such as one sees in poplars, elms and willows. Eucalypts do not sucker (except rarely and accidentally), and the authors use the word in the sense of "coppice-shoot." No doubt "sucker" is an Australian colloquialism, but naturally the use of slang expressions is to be avoided in a scientific work. To be accurate the authors should use the term early or first foliage, or its equivalent, since this important diagnostic feature is seen in the first foliage of Eucalypt seedlings equally with coppice-shoots.

As yet no one of the Australian colonies has taken the first step in scientific forestry. Though Mr. Maiden in his various writings has let in a flood of light on the subject, and the student of Eucalypts stands deeply in his debt, there is not a line by a scientifically trained forester descriptive of the forests of Australia. There is no want of liberality on the part of Australia in endowing the researches of scientific men living in cities, but there is a woeful neglect of forestry in the field. Scientific forestry as understood on the Continent of Europe is unknown in Australia, and unless the Commonwealth can bring its attention to bear on the terrible waste of its natural forest resources now going forward, its future history will be a black one, comparable only in modern times to that of the Spaniards in Mexico.

In the older settlements of East Australia the forests, pillaged of their best species, or burnt and ruined, have greatly declined in value. Gone are the valuable reserves of iron-bark, tallow-wood, and forest mahogany among the Eucalypts, and the splendid cedars (*Cedrela toona*) which should have been the country's pride. South Africa is getting most of its timber from the comparatively newly settled West Australia. The Australian has yet to learn to take the honey without destroying the bees!

When your reviewer takes us to America, we get amongst a people awakening to the fact that there is such a thing as scientific forestry. As he remarks, the American volume on Eucalypts is excellently got up. It is a pleasure to turn over the pages with their life-like pictures of Eucalypts. It is not likely, however, that there will ever be any great production of Eucalypt timber in North America. It is only South California that quite repeats any Australian climate, namely, South-West Australia. It is doubtful if Eucalypts will ever do much in the eastern States. The Gulf States, which are alone suited to Eucalypts, have their cold snaps and freezes, together with an all-the-year-round rainfall which we do not find in Australia, while there is

an abundance of good hardwood already in the country, and the four pitch-pines, rivalling hardwoods in strength and durability. Eucalypt culture in America is still in its infancy; they have not yet discriminated the valuable from the many worthless species, nor fitted, as far as may be, the species to its climate.

D. E. HUTCHINS.
E. HUTCHINS.

Cape Town, June 23.

A Simple Form of Tide Predictor.

FOR the past four years a very simple form of tide-predicting machine, the invention of Captain A. Inglis, the harbour-master, has been in use at Port Adelaide for the construction of the yearly published tide tables. The tides at Port Adelaide are rather peculiar in their behaviour, this being due principally to the fact that the solar and lunar semi-diurnal components are almost exactly equal. At and near the neaps these neutralise one another, and the diurnal components, which are relatively large, are then the main sources of the tidal movement. Before these tides were harmonically analysed, their prediction by ordinary methods was quite impossible, except near the springs. By means of this machine, however, they are now predicted yearly with considerable accuracy. The essential principles of the machine are as follows:—A number of thin wooden templets are cut, each in the form of a sine curve, representing the various tidal components (Fig. 1). These waves are of different lengths, the length of each component wave bearing

FIG 1.

the same ratio to the solar semi-diurnal as its angular speed does to 15°. The templets are all fixed side by side, with their planes vertical and parallel, being supported on a carrier, which can be moved forward in the direction of the waves by means of a rack and pinion underneath. A number of vertical plungers rest in a transverse line with their lower ends resting on the tops of these templets, and are moved up and down as the curves progress forward. The motions of the plungers are then compounded by means of a fine wire passing over pulleys at the top of each one, and under fixed pulleys between adjacent ones. This wire is connected to an indicator, which moves up and down alongside a vertical scale, thus marking the height of the compound wave at any instant.

The wire passing over the plungers is an endless wire, going round a pulley on the indicator and round a larger pulley at the other end of the line of plungers. This larger pulley is attached to a plate which is movable backwards and forwards by means of a fine screw. This gives a means of adjusting the height of the indicator, and also of allowing for the effect of the annual and semi-annual tides. The rise or fall due to these long period tides is treated as constant for fourteen days, and the screw adjusted so as to alter the height of the indicator by the proper amount at the end of each such interval. In front of the frame of the machine, between it and the indicator, is a vertical slide, which is moved forward at the same rate as the carrier, and carries a sheet of paper on which the tidal curve may be traced if required (Fig. 2).

Each templet is fixed in the carrier in proper relative position according to its phase at the start, as determined by previous harmonic analysis. When the handle of the machine is turned, the carrier, vertical slide and clock are set in motion, and the indicator shows the height of the

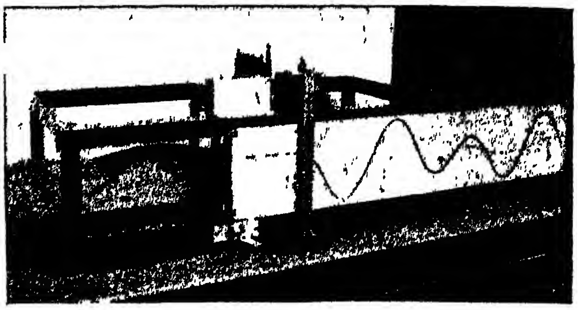


FIG. 2

tide at the time shown by the clock, and the curve may at the same time be traced on the vertical slide.

There are three carriers and three or four templets to each component. When one of the carriers has been worked forward far enough, it can be disconnected from the others and connected up again at the other end. The curves are again placed in their respective grooves, and, by means of a suitable attachment, butted close up to the preceding ones. In this way the process is made continuous.

The setting of the curves can easily be checked at every month, to see that there has been no slipping.

The machine involves no expensive construction, and enables a year's tides to be predicted expeditiously, and, as experience has proved, with quite sufficient accuracy.

The University, Adelaide. R. W. CHAPMAN.

[In a subsequent letter, Mr. Chapman informs us that he made the following errors in the list of values of the tidal components at Port Darwin, printed in last week's NATURE (p. 295). "The amplitude of N should be 1·04, of ν 0·48, and of T 1·53. The phase of ν should be 141°, and that of T 70°."—ED. NATURE.]

Sympathetic Song in Birds.

IN your issue of April 30 (vol. lxvii. p. 609) Mr. George Henschel describes an interesting vocal duet between a bullfinch and a canary, and invites contributions to the subject.

In 1893 I obtained a nestling Australian magpie (*Gymnorhina tibicen*, Latham), and taught it on the flute to pipe the following:—

Some years later I acquired another bird of the same species; this learned the tune from the original magpie. I do not know how the birds agreed upon the duet (or fugue) rendering, but it was performed in the following way:—When the first bird commenced its song, the second one immediately came to attention, and with half-open beak awaited the point marked *, whence it finished the strain alone. The birds were kept in a large outdoor aviary in company with many others, and no matter where or how engaged, the second bird would, on hearing its mate, assume an attentive attitude, and await the conclusion of the first portion of the theme.

The second bird died, and the original one, which I still have, now pipes the whole strain alone, as was its original custom.

I may also mention that this bird has the faculty of absolute pitch, and pipes the theme in F as originally taught.

EDGAR R. WAITE.

Australian Museum, Sydney, June 18.

THIRTY YEARS OF UNIVERSITY EDUCATION IN FRANCE.

THE modern conception of a University in France dates from the Revolution. In place of the old Sorbonne, veritable Bastille of scholasticism, the new University was conceived as a kind of laboratory and clearing-house in which every form of knowledge was to be pursued or dispensed. Yet in spite of the multiplicity of the subjects, unity was to be secured by the natural connection between the different branches and the common aims and ideals of the teachers themselves. Unfortunately the Revolution failed to realise the grandiose ideas of Talleyrand and Condorcet. With the exception of the Institute, the only establishments it created were the so-called "special schools" limited to the study of a single science or group of subjects, such as, for instance, the school of mathematics, the school of medicine, the school of Oriental languages, &c. To these the Consulate added the schools of law and altered the title of many of these schools into that of "faculties." It further increased the number of faculties by adding those of letters and of science. The research side of university work was ignored, the faculties were mere examination machines for turning out professional men. The only university was the University of France, which, though made a corporate body by Napoleon, was above all things an institution for the propagation of an official education most favourable to Imperialism. To this university all the different faculties in the different towns were subordinated. But here all connection ended. Although often existing three and four together in the same town, they were completely strangers to one another, having no unity or even relationship with one another, almost entirely devoid of the necessary resources, not merely for original investigation, but also for their ordinary work.

The evils arising from such an excessive centralisation combined with the practical isolation of the local faculties were certain to make themselves felt in the long run. "Paris," wrote Guizot in his "Memoires," "morally attracts and absorbs France." For this, in his eyes, the only remedy was the creation of a few large provincial universities. Recognising the impossibility of creating seventeen complete and fully equipped universities, he proposed to limit their number to four. Unhappily he was in advance of his time. The second Republic reduced the status of the university itself from that of a corporation to a mere branch of the central Government. The most enlightened Education Minister of the Empire, Victor Duruy, seeing the impossibility of reforming the faculties, determined to establish alongside of them a scientific institution called the École des hautes Études, which reminds one, though its scope was wider, of the Royal College of Science, inasmuch as the savants who formed the "personnel" were chosen on their merits alone, and no question was made as to whether they were members or not of the university. The school had no fixed quarters, but any professor of ability in the Sorbonne, the Collège de France, the Museum of Natural History, or in any laboratory, was pressed into the service of this new corps of learned and scientific teachers. The effect of the opening of this "opposition shop" was most beneficial on higher education throughout the whole of the country.

Nevertheless the general condition of higher education was, in the words of M. Liard, "very lamentable, and what was most lamentable of all was not the insufficiency of the buildings, the poverty-stricken state of the laboratories, collections and libraries, or the dearth of resources, but the almost absolute misconception of their real functions by the professors of those faculties which ought to have been above all the instruments of scientific progress and of the propagation of scientific methods. With a few exceptions, in the faculty of letters the teaching was above all rhetorical and fashionable, in that of science it was nearly everywhere limited to the mere popularisation of discoveries. The highest work of university education, the training and formation of the man of science, was almost unknown. The admirable savants of the time were self-taught persons without a university degree."

Such was the state of things when the disaster of 1870 occurred. With the conclusion of peace, savants and patriots joined forces in favour of a radical reform of the university system. It was felt that inefficiency in higher education had been one of the causes of national defeat.

The most competent judges were agreed that the essential defect in university education was the multiplicity and isolation of the faculties. The remedy in their eyes was the concentration of the faculties of the different orders into a limited number of "powerful centres of study, science and intellectual progress." Jules Simon affirmed the necessity of "having a certain number of intellectual capitals in which are to be found united all the necessary resources for the complete development of the young." Again, according to M. Laboulaye, universities were the one thing needful. "Let them cease to scatter over the surface of France faculties the isolation of which condemned them to sterility."

Some of the strongest arguments in favour of reform came from the men of science of the day. It was pointed out that the duty of the Universities was not merely to distribute the existing stores of knowledge, but also to lead in the van of discovery. "Close the laboratories and libraries," said Bertholet, "stop original investigation and we shall return to scholasticism." Insistence was also laid on the extreme value of scientific discovery as a factor in the industrial struggle between the different nations, while at the same time the importance of introducing the scientific spirit into the mental life of a people only too often swayed by sudden emotions was strongly emphasised.

But the advocates of university reform had a very serious difficulty to encounter at the outset. Alongside of the faculties there already existed the big scientific establishments like the Collège de France, the Museum of Natural History, and the professional schools, such as the École Polytechnique and the École Normale, in which the flower of military engineers and university professors were being trained. All these bodies were bitterly hostile to incorporation. Fortunately they were all situated in Paris, where in reality there was room both for themselves and the University. The main problem after all was the creation of provincial universities.

Here the difficulties were far more real and pressing. To begin with, many of the existing professors in the faculties were by no means in sympathy with the reformers. For them the function of the faculties was to turn out lawyers, magistrates, doctors, pharmaceutical chemists (the calling of chemist in France ranks as a liberal profession); not to conduct original research. Did not the Collège de France and the Museum of Natural History exist specially for these purposes? The answer was one which has since been given in higher technical education in England and elsewhere, that science should be the centre of professional training. Practice without science was pure empiricism, and empiricism was out of date. Claude Bernard had already converted medicine into an experimental science, and the historical method had wrought a similar transformation in the study of law. Whether the faculties remained isolated or not, they would henceforth have to

adopt scientific methods. Naturally every student could not be turned into a man of science, but every one had a right to know the scientific truths on which his professional education was based, while the small élite of really talented students should have the opportunity of engaging in scientific investigation. In the case of these exceptional students the method of working in common with their masters had hitherto been largely neglected. Yet its importance in working out a discovery to its fullest extent is not only beneficial to all parties, but often of the highest importance to the country at large. Another objection urged by the opponents of reform was that a university by definition implies the concentration of subjects, whereas modern science on the contrary is fissiparous by nature, ever splitting up into new branches and specialities. To this it was easily answered that one of the chief dangers of the day was excessive specialisation, and that the university is therefore the best antidote, as its chief function is to coordinate knowledge and make it a general object of culture. Warned by the excessive specialism that is rampant in German universities, the French have taken for their motto, "Specialisation subordinated to a general culture."

In 1883 Jules Ferry brought the question within the sphere of practical politics by a circular addressed to the faculties; after speaking of the efforts he had made to develop in higher education the sentiment of responsibility and the habit of self-government, he went on to say:—

"We shall have obtained a great result if we are able to constitute one day universities uniting within themselves the most varied kinds of teaching, in order mutually to assist one another, managing their own affairs, convinced of their duties and of their merits, inspiring themselves with ideas suitable to each part of France with such variety as the unity of the country allows, rivals of adjoining universities, associating in these rivalries the interest of their own prosperity with the desire of the big towns to excel their neighbours and to acquire particular merit and distinction."

In conclusion he invited the faculties to give their opinions on his suggestion. These were, in the main, favourable. It was left, however, to his successor, M. René Goblet, to take the first official steps. It was evident to all that the new universities could not be constituted after some ideal plan, but would naturally have to be built up out of the existing faculties. To group the latter in collective wholes, effacing all distinction between them, would have proved too drastic a measure. The best way of building up a university was to begin by strengthening and not by weakening the faculties. This was done by restoring to them the "personalité civile" which had lapsed, and recognising their capability to receive and hold property. At the same time another decree, without giving them the absolute right to frame a budget, allowed them the right to expend all subventions, to which no conditions had been attached by the parties making them, whether departments, communes, or private individuals, on the creation of new courses of instruction, on laboratories and libraries, and on scholarships. To regulate this expenditure a council was created called the "Conseil général des Facultés." This council, established for purely financial reasons, was destined to become the real nucleus in the development of the universities. As M. Liard has well said, "the decree of 28th December, 1885, was truly the provisional charter of the universities before the universities." Linking together the faculties of a single town, the Council not only dealt with the functions for which it was first created; it was soon allowed, under certain conditions, to draw up the programmes of courses and lectures, to exercise certain disciplinary powers, to make financial proposals to the Minister, and to engage in a multiplicity of tasks which fall to the lot of an ordinary university to perform. In 1889 the separate faculties received the right to frame budgets of their own. At the same time those grants were directly paid to them which the Ministry previously had itself expended on buildings and equipment. So far the Government had only proceeded by way of decrees, a method which is not unknown in England, and corresponds roughly to an order in council, but in 1890 the moment seemed to have come for legal enactment, and M. Léon Bourgeois, the then Minister of Public Instruction, brought forward a Bill to settle the whole subject once for all.

Nothing gives a better idea of the enormous sacrifices made by the Republic for the sake of higher education than the preamble of the Bill, which ran as follows:—

"The Republic has understood that university education is in the highest degree necessary; that if primary education is, according to the phrase of one of our predecessors, the canalisation by which knowledge is distributed to the very lowest strata of democracy, university education is the source where it collects and whence it flows. It has understood that a particular dignity and utility are attached to this grade of education, that in it especially are formed and trained the men who are capable of conceiving general ideas, by the power and novelty of which the real influence of nations is measured to-day. Therefore it has liberally given to it the necessary millions which had been persistently refused by former administrations.

"In the last 15 years it has renewed the buildings of the faculties.

"It has supplied almost entirely their equipment, their laboratories, their libraries.

"It has enlarged and increased the scope and range of their teaching.

"It has more than doubled their budget.

"It has improved the position of the 'personnel' and endowed their teaching with the requisite resources.

"It has created two categories of student, formerly unknown in France, students in science and in letters.

"It has introduced more science into those courses in which the preoccupations of professional studies predominated, and it has imposed a professional task on those orders of faculties which were without it.

"It has restored to the faculties the 'personalité civile,' a right which a suspicious *régime* had denied they possessed.

"It has rendered relationship possible between them by giving them a common function to fulfil.

"It has given full liberty to science and theory.

"It has favoured the coming together of students as well as that of teachers.

"In conclusion it has seen the number of its students rise from 9000 to more than 16,000, foreigners returning to its schools, and frequenting them in greater numbers than in any other country in Europe."

The Bill itself proposed to create universities in the fullest sense of the word out of the existing groups of faculties in the seven largest towns. Unfortunately local influences proved too strong; the other ten towns possessing two or more faculties demanded equality of treatment. The former adversaries of the project joined forces with them; and in the end the Government was obliged to withdraw the Bill.

Beaten on the question of establishing local universities of the fully equipped type, the reformers took once more the line of least resistance, and in 1893 an Act was passed investing with the "personalité civile" the groups of faculties formed by the union of several faculties, and represented by the Conseil Général. This was followed in 1896 by an Act introduced by M. Poincaré, which converted these groups of faculties into

universities. The idea of full and complete universities, which had been the underlying conception of the Bill of 1890, was abandoned, and wherever an academy existed, even if it had but two faculties, its place was taken by a university. As M. Liard well says, "it was a choice between having too many universities or of having none." To provide funds, the tuition fees, which had hitherto gone to the Treasury, were handed over to the new bodies. The examination fees, however, were still retained by the Treasury. The law contained but four clauses. The first decided that the groups of faculties should take the name of universities. The second decided that the Conseil Général should receive the title of university council. The third enlarged the disciplinary powers of the new council. The fourth dealt with the financial arrangement mentioned above, the new funds provided being "earmarked" for certain definite purposes, such as expenditure on laboratories, &c. Certain other financial rearrangements were made, with the result that the extra cost to the State came to about 15,000*l.* a year. The existing "personnel" was paid, as before, by the State, and the regular grant, variable year by year, for buildings and equipment was likewise continued. By the law of 1899 the universities were allowed to establish "degrees of a purely scientific kind." This was largely done to encourage the attendance of foreigners, while the proviso that they conferred no rights or privileges safeguarded the State from incurring any responsibilities *vis à vis* their recipients.

The preamble of the Bill of 1890, quoted above, gives an adequate summary of the progress made from 1870 up to the university year 1888-1889. More detailed information of the progress since that date is to be found in the "Statistique de l'Enseignement Supérieur," which brings up the record to the university year 1897-98 (the last year available). The following are some of the principal items of interest. Though the French universities have not, with very rare exceptions, found any benefactors on the scale of the Rockefellers and Carnegies, the list of benefactions published in full shows that the power of the new universities revived in 1875 to receive donations and legacies has not remained unappreciated. The University of Paris has received such lump sums as 210,000*l.*, Montpellier such as 60,000*l.*, while several have received donations of 4,000*l.* or less. In 1889 the annual grant from the State amounted to about 456,284*l.* In 1898 it was more than 523,640*l.*, showing an increase of 67,000*l.* odd over the grant of ten years before, which itself was more than double the grant under the Empire. Though the universities received the above sums in hard cash, the actual cost to the State was less, as one must deduct from it the fees for degrees, which, as has been already stated, go into the coffers of the State. These amounted to 5,135,162 francs in 1898, or, roughly, 205,406*l.* The net expenditure, therefore, of the State was about 318,000*l.*

The departments and municipalities make contributions to nearly all the universities, their contributions being "earmarked," as a rule, for specific purposes. They practically support all the medical schools, whether situate at the seat of the university itself or within its area of control, the only exceptions being Paris and Bordeaux, which also receive a State subvention. The contributions of the departments and municipalities to the budgets of the university and faculties amount to about 68,000 francs and 132,000 francs respectively; their contributions to the medical schools unsupported by the Government, and to the so-called preparatory classes in letters and science amount to about 135,500 francs and 882,000 francs respectively. The total income of the universities, including these medical schools, but excluding the Collège de France, the Museum, and the various special schools, amounts to about 14,142,000 francs for the universities, and 1,582,858 for the medical and preparatory schools, in all a grand total of about 15,725,000 francs. Towards this total the State contributes 13,096,664 francs, the departments about 203,000 francs, and the municipalities about 1,014,000 francs; the rest is made up of students' fees, legacies, and contributions by societies and private persons. As, however, the towns receive from university sources the sum of 421,837 francs, their net contribution is only about 593,000 francs, or roughly about 23,720*l.*

Since 1888-89 the number of students has risen in a remarkable fashion, though no doubt this increase is due in part to the law which grants two years' exemption from military service to those who have passed certain examinations. In 1888-89, the number of students was about 16,000, in 1898 the total had risen to 28,782, of whom 871 were women, and no less than 1784 of foreign nationality. All the faculties show an increase in the number of students during the same period, but those in science (a school which did not exist before the Republic) show the greatest increase. Their numbers have risen in the last ten years from 1187 to 3424.

The Baccalauréat shows the same remarkable increase. Certain changes in the examination do not permit of a comparison being drawn with any year earlier than 1892–93. In that year there were 25,612 candidates for the different sections of the examination, of whom 11,518 passed. In 1897-98 there were 36,922 candidates, of whom 16,688 passed. The other establishments of university rank, the Collège de France, the Museum of Natural History, the École Normale Supérieure, the École pratique des hautes Études, &c., all received an increased grant in 1898 in comparison with the last decennial account. The Collège de France, which is entirely devoted to research work, contains no less than forty-two chairs, and receives from the State nearly 21,000*l.* a year. The Museum of Natural History, equally devoted to research, has a budget of more than 38,000*l.* The school of Oriental languages, which has no counterpart in England, though we have a far greater need of one, receives more than 6000*l.* a year. The École des Chartes receives more than 3000*l.* The École pratique des hautes Études receives more than 12,500*l.*, as well as more than 1500*l.* a year from the City of Paris. The majority of these institutions have enormously developed, if they have not been actually created, under the Republican *régime*.

One word must be said in conclusion for the free universities founded in 1875, when the university monopoly in higher education was abolished. At first permitted to grant degrees similar in name to those of the official world, they have since lost the right. In spite of this they have none the less continued to increase. In 1888-89 their students numbered 726, in 1897-8 they had increased to 1407. It is difficult to say what will be their fate under the present campaign to re-establish the monopoly of the State in education. The higher schools of art and technology being under more or less separate authorities do not figure here in the list of higher education.[1] The present *régime* has been equally liberal and equally successful in dealing with these important branches of national education. Whatever may be the final verdict of history on the Republic, its bitterest critics will never be able to contest the fact that only Prussia after Jena can compare in any way

[1] The schools of art are under a separate department in the Ministry of Public Instruction and Art. The higher schools of commerce and technology are under the Ministry of Commerce.

with the thoroughness and success with which it has reformed and revivified every branch of higher education.

CLOUDESLEY BRERETON.

Principal works consulted :—" Ministère de l'Instruction Publique et des Beaux Arts; (1) Statistique de l'Enseignement Supérieur; (2) Introduction à la Statistique de l'Enseignement Supérieur, par M. L. Liard, Directeur de l'Enseignement Supérieur. (Paris : Imprimerie Nationale, MDCCCC.) (3) " Législation et Jurisprudence de l'Instruction Publique. Extrait du Répertoire du Droit administratif." Première partie, Historique et Organisation générale; Deuxième partie, Enseignement Supérieur; Sixième partie, Écoles ne relevant du Ministère de l'Instruction Publique. (Paris : P. Dupont, 1903.)

THE RESUSCITATION OF THE APPARENTLY DROWNED.

IN 1862 a committee, which included several eminent medical men and physiologists—amongst the latter Dr., now Sir, John Burdon Sanderson—was appointed by the Royal Medical and Chirurgical Society to investigate the phenomena attendant upon drowning, and the methods which had been recommended for the recovery of apparently drowned persons. That committee made a number of experiments in man upon the dead subject, and upon animals during life, and the results they obtained were duly published in the *Transactions* of the society. But it appeared important to renew the inquiry with modern methods, and a second committee for the investigation of this important subject was accordingly appointed a few years ago, with Prof. Schäfer as chairman. This second committee attempted, in the first instance, to pursue the inquiry as to the best means of carrying on artificial respiration, in the same manner as the 1862 committee, *i.e.* upon the cadaver, but met with grave difficulties from the outset in the enormous resistance which the condition of *rigor mortis* sets up to effecting changes of volume of the chest, a difficulty which had been also met by the earlier committee, and very imperfectly surmounted. The new committee accordingly decided to discard the cadaver, and to endeavour to determine in the living human subject how great an amount of air could be moved into and out of the lungs by movements imparted to the thorax by the agency of external force. This force was applied either by intermittent traction upon the arms, or by intermittent pressure upon the thorax, the subject being either in the supine or prone position, and remaining perfectly passive during the short period of the experiment. The amount of air taken in and given out was measured in a graduated vessel, or by means of an ordinary gasometer.

The results showed that by all methods which have been suggested for the performance of artificial respiration, viz. the Silvester traction method, the Marshall Hall rolling method *plus* compression of thorax, the Howard method of compression of thorax in the supine position, and also a similar method of pressure upon the thorax with the subject in the prone or semi-prone position, an amount of air can be drawn into and driven out of the thorax which is at least as great as the amount of air exchanged in the ordinary tidal respirations of the individual. This being so, it is evident that, in selecting a method of artficial respiration for restoring the drowned, one should be guided less by the actual amount of air which any given method is capable of exchanging than by other considerations, such as the facility offered for the escape of water and mucus from the air passages, and the preventing of the tongue from falling back and blocking the fauces, both of which objects are better attained by the lateral and prone than by the supine position. It was further clear that it is more easy to effect artificial respiration by exerting intermittent pressure upon the thorax than by arm traction, and although the committee do not give instructions for the restoration of the apparently drowned in their report, it is obvious that their conclusions point to the adoption of the prone or semi-prone position of the subject, and to rhythmically intermitted pressure upon the thorax, as the methods which are likely, in the circumstances of drowning, to yield the best results.

The experiments upon animals (which were performed almost entirely upon anæsthetised dogs) are, it is believed, the first in which all the phenomena connected with the circulation and respiration have been graphically recorded during the process of drowning and subsequent resuscitation by artificial respiration. The chief points which they illustrate are the very large amount of water which can be taken into the lungs and become entirely absorbed into the system within a few minutes, without producing any but quite temporary symptoms, the great amount of vagal stimulation which is produced during drowning, and which is, in some instances, sufficient to arrest the heart's action almost entirely, and the extreme variability in the power of resistance to drowning in different individuals of the same species, so that, while a submersion of two minutes is fatal to some individuals, one of seven or eight minutes, or even more, can be borne by others with a fair chance of recovery as the result of the application of artificial respiration. The experiments all point to the supreme importance of commencing artificial respiration at the earliest possible moment, and are, therefore, condemnatory of all instructions for the recovery of the apparently drowned which direct that, before proceeding to apply artificial respiration, the patient should be divested of clothing, hartshorn should be applied to the nostrils, and various other remedies attempted—all of which merely serve to waste time, every second of which is invaluable for combatting the actual condition which is threatening life, viz. the lack of oxygenation of the blood. Incidentally it was found in the course of these experiments that, without sufficient aëration of the blood, even the most powerful cardiac and vascular stimulant—such, for example, as the extract of suprarenal capsule—is entirely unable to assist recovery.

The experiments upon the cadaver were chiefly performed by Mr. Pickering Pick, Mr. Henry Power, and Dr. J. S. Bolton, in London; those upon the living subject by Prof. Schäfer and Dr. P. T. Herring in the physiological laboratory of the University of Edinburgh. The report of the committee was read by Prof. Schäfer at a largely attended meeting, held on May 26 last, at the rooms of the society in Hanover Square.

NOTES.

WE regret to learn that on Saturday, July 25, M. Prosper Henry, of the Paris Observatory, was found lying dead in the La Valoise Valley near Pomogen at an altitude of 1600 metres, in the French Alps. His death appears to have been due to congestion caused by extreme cold. M. Henry was buried at Nancy, his birthplace, on August 1. A number of astronomers was present at the sad ceremony, among them being M. Callandreau, of the Paris Academy of Sciences; MM. Borchart and Fraissinet, of the Paris Observatory; and M. Trépied, director of the Algiers Observatory. M. Prosper Henry and his brother, M. Paul Henry, were attached to the Paris Observatory in 1865, and their work is well known in the astronomical world. Between 1872 and 1882 they discovered fourteen asteroids,

and in the latter year took up the work in celestial photography which has rendered their name famous. It is not too much to say that in many ways they have been the real founders of La Carte du Ciel.

AN International Conference on Wireless Telegraphy was opened at Berlin on Tuesday. We learn from the *Times* that Great Britain is represented by Mr. J. C. Lamb, Mr. J. Gavey, and Mr. R. J. Mackay, of the General Post Office, Captain H. L. Heath, R.N., Lieut. C. R. Payne, R.N., and Colonel R. L. Hippisley. Herr Kraetke, the Imperial Secretary of State for the Post Office, who opened the conference, said that it was intended "to make a clear road for the further extension of wireless telegraphy in order that, all special interests being set aside, the new means of communication might gradually develop to the common benefit of all seafaring peoples. This could only be brought about by the harmonious cooperation of the States interested in the shipping trade." The business of the conference is, however, only preliminary, the main object being to fix upon matter for discussion at a subsequent international conference. This later conference will probably be largely occupied in considering the possibility of standardisation with a view to intercommunication between different systems. We have often pointed out in these columns the extreme desirability of such intercommunication from the point of view of public safety and convenience. When the problem of syntonisation is solved, it will no doubt be possible for one system to work entirely independently of all others, but until that time it is practically necessary that some working arrangement should be made between the different systems which will allow the public to derive from wireless telegraphy the full advantage that it can, as yet, bestow.

MR. R. LYDEKKER, F.R.S., has been elected a foreign member of the R. Accademia dei Lincei, Rome.

MR. W. R. OGILVIE-GRANT, of the Natural History Museum, has returned from his trip to the Azores with a large collection of birds, insects, and land molluscs, the latter including some forms of special interest.

WE learn from the *Times* that Dr. Ludwig Mond, F.R.S., whose death was incorrectly announced by some papers last Saturday, is approaching complete recovery from a nervous breakdown on the shores of Lake Leman.

THE Civil Service Supplementary Estimates include the sum of 45,000*l.* to pay the expenses of the two relief ships *Morning* and *Terra Nova,* which are being sent out by the Admiralty to the relief of the *Discovery*. The estimate includes provision for the purchase of the *Terra Nova* and for the wages of the crews of both vessels; also for stores, coals, provisions, &c.

SEVERE earthquake shocks were experienced in several parts of Italy and Spain last week. Reuter's correspondent at Rome states that several houses and churches at Filattiera and Mulazzo were destroyed by an earthquake on July 31, and a message from Madrid states that at Albuñon, in the province of Granada, severe earthquake shocks, followed by loud and prolonged subterranean rumblings, were felt on July 26, 27 and 28.

THE council of the Institution of Electrical Engineers has now, with the approval of the Physical Society, undertaken the publication of *Science Abstracts* as an Institution publication. In connection with this work, Mr. Louis H. Walter has been appointed editorial assistant to the secretary, and will take up his duties in the autumn.

THE death is announced of Prof. Edmond Nocard in his fifty-fourth year. Prof. Nocard, who was principal of the Veterinary School at Alfort, near Paris, had a world-wide reputation as a veterinary pathologist, and was the author of several important works, of which his "Maladies microbiennes des Animaux" (written in collaboration with Prof. Leclainche) has just reached a third edition. He was also one of the co-editors of the Pasteur's *Annals*. He attended the Tuberculosis Congress in London in 1901, and was a strenuous opponent of Koch's view of the non-transmissibility of bovine tuberculosis to man.

A MEETING of the general committee of the Cancer Research Fund was held on Friday last, July 30, Mr. Balfour, one of the vice-presidents, occupying the chair in the absence of the president, the Prince of Wales. The first annual report, which was submitted, showed that a large amount of preliminary work had already been accomplished during the few months the Cancer Research Fund has been in existence. It was deemed premature to make any detailed statement of the experimental work in progress, but an indication was given that considerable importance is attached to the study of cancer as it occurs spontaneously in the lower animals. For the purposes of this branch of the inquiry, it is sought to secure adequate farm accommodation. Certain statistical data are also in progress of compilation with regard to the proportion of cases in which the clinical diagnosis is verified by the pathological findings, in order that the value of the data upon which existing statistical conclusions are based may be determined and sources of fallacy obviated in future. Sir William Broadbent, in moving a vote of thanks to Mr. Balfour, stated that he thought that in the course of the work now being inaugurated, the nature, cause, and cure of cancer would be arrived at. Whatever method of cure might be proposed, it would receive careful investigation. Mr. Balfour, in his reply, alluding to the interest which everyone must take in the cancer problem, said he was surprised that only 213 persons had contributed to the fund. One anonymous donor had promised 5000*l.* if thirteen other individuals, or groups of persons, would each contribute a like amount, but up to the present this appeal had not been successful. Considering the progress that had been made in all departments of medical science during the last century, he believed that there was every reason to hope that the investigations of the committee would ultimately prove successful. The Cancer Research Fund now amounts to about 52,000*l.*, but in order to pay the expenses of the work out of the income of the fund, the amount originally estimated, viz. 100,000*l.*, will be necessary.

A CORRESPONDENT of the *Times* states that Lieut. Kolchak has started from the Arctic coast for the New Siberian Islands in search of Baron Toll, the head of the Russian Polar expedition which left St. Petersburg three years ago in the yacht *Zaria*. If Baron Toll be not found on the New Siberian Islands, then Lieut. Kolchak will endeavour to reach Bennett Island, about eighty miles further north-west. A year ago last May Baron Toll, with the astronomer Seeberg and two native Yakuts, left the *Zaria* off Kotlin Island with a view of reaching Bennett Island over the ice. In case the *Zaria* should not be able to follow them, which eventually turned out to be the case, the party hoped to be able to return independently to the New Siberian Islands; but it is supposed that Baron Toll had not dogs enough with him for this purpose, and was therefore obliged to winter on Bennett Island. In regard to food, all the members of his party are excellent hunters, and in case

the baron should have succeeded in making his way back to the New Siberian Islands in the spring, he and his companions will have an ample supply of provisions in the stores which he himself left there for Nansen in 1893. According to notes left by Seeberg on New Siberia, which is the last news received of the expedition, Baron Toll's party must have left there about the beginning of July of last year to explore Bennett Island.

IT is announced that a wireless telegraphy station is to be erected at Port Arthur at a place known as Golden Mountain. The object is to establish regular communication with Russian warships in the Gulf of Pechili. The system to be used is not stated.

THE Cable Makers' Association, which represents the chief makers of insulated wire in this country, has decided to put on the market a special quality of flexible cord which shall be quite safe and trustworthy under all conditions of ordinary use. The importance of installing good quality flexible cord cannot be overestimated, as the loose wire is subjected often to rough treatment, and is very liable to be in the neighbourhood of inflammatory material. The cord which the Association proposes to make is to be insulated with pure and vulcanised indiarubber, and will have a minimum insulation resistance of 600 megohms per mile after twenty-four hours' immersion in water; the insulation will also be tested with 1000 volts alternating current for fifteen minutes. The cord will bear a special label and trade mark for the purpose of distinguishing it.

THE twenty-fifth annual report of the Deutsche Seewarte for 1902 will be noteworthy in the history of that useful institution by the retirement of Dr. von Neumayer, who had been director since January, 1876, and of Captain Dinklage, marine superintendent, after twenty-two years of very active work. The long list of meteorological logs received from the navy and mercantile marine shows that this branch of the service has been carried on with great activity; 556 steamships and 198 sailing vessels contributed observations during the year. The results appear in various useful publications, including daily synoptic charts and monthly pilot charts of the North Atlantic Ocean. The department of storm warnings and weather telegraphy has also been conducted with unabated vigour, to the success of which the recent establishment of a telegraphic service at 7h. a.m. has greatly contributed. The daily weather report issued by this department is one of the most valuable publications of the Seewarte, and includes observations from all parts of Europe.

WE have received the report of the Government astronomer of Western Australia, containing meteorological observations made at the Perth Observatory and other places in the colony during the year 1901. Very complete observations are published for the observatory, including temperature of the soil and evaporation, together with monthly means from the year 1876. General summaries are also given for more than forty climatological stations and rainfall statistics for a large number of places. Morning and evening weather forecasts form part of the routine work, and the results show that they have been remarkably successful; the general forecasts issued at noon, for the whole State, attained a complete success of 93 per cent. During the latter portion of the year astronomy also formed a prominent feature of the work of the observatory.

IN the *Zoologist* for July Mr. T. E. Lones discusses the identification of some of the birds mentioned by Aristotle, and shows that certain of the names have a generic rather than a specific sense. It appears that the name *boscas*, now used for the mallard, really indicates the widgeon, while *netta*, now employed as the generic title of the red-headed pochard, properly denotes the first-named bird. In a second article Mr. R. C. J. Swinhoe publishes a fuller account of the *gisement* of the now celebrated chipped flints from Yenangyoung, Burma, and concludes that, in place of Pliocene or Miocene, they are really of late Neolithic, if not of the Iron, age. Mr. Lydekker has a note on the gaur of Burma, which is regarded as subspecifically distinct from the wild ox of India, and named *Bos gaurus readei*.

A COLLECTION of molluscs from the Vicksburg marls has enabled Mr. T. L. Casey to describe a considerable number of new species and genera in a recent issue of the *Proceedings* of the Philadelphia Academy. In the same journal Mr. A. E. Brown attempts to bring into something like order the various forms of garter-snakes (Eutænia) from the Pacific Coast of North America which have received distinct specific and subspecific names. Much interest attaches to a note by Miss S. P. Monks in the serial under consideration in regard to regeneration in starfishes. It has been stated that a fragment of a ray, without any portion of the central disc, cannot give rise to a new animal. This is disproved by the new experiments, in which the amputated free rays developed new bodies, while the mutilated starfishes produced new rays.

FROM among a series of papers published in the *Proceedings* of the U.S. Nat. Museum, special mention may be made of the following. In No. 1345 Mr. B. A. Bean records from Barbados an example of the small eel, *Ahlia egmontis*, hitherto known only by the type specimen from Florida. Reference is also made to a third example of the species from Florida. In No. 1341 the Rev. T. R. R. Stebbing describes two new species of amphipod crustaceans from Costa Rica. The walking-stick insects (Phasmidæ) of the United States form the subject of a paper (No. 1335) by Mr. A. N. Caudell, while Mr. W. H. Dall (No. 1342) contributes a synopsis of the bivalves of the family Astartidæ, with special reference to the American species. Finally, Mr. S. F. Clarke (No. 1343) shows that the Alaskan hydroid polyp, described by himself as the representative of a new family and genus (Rhizonema), belongs to one or other of the well-known genera Corymorpha and Lampra, the imperfect condition of the Alaskan specimens preventing closer identification.

IN *Animal World Illustrated* (the official organ for the R.S.P.C.A.) for July, Mr. E. V. Windsor, in an article entitled "Reflections by a Lover of Nature," passes an unqualified condemnation on insect collecting, as practised by the school-boy and the amateur entomologist. Stuffed birds as objects of decoration are likewise condemned, and we presume, although this is not stated in so many words, that collections of birds' skins, except in museums, would likewise come under the writer's ban. While we have much sympathy with Mr. Windsor's views, more especially as regards the stuffed birds, we believe that he carries these views somewhat too far. For instance, when he says that "there is little or nothing to be learnt from a creature when dead," we beg to join issue with him. Again, we have the following passage:—"In every branch of natural history this wanton slaughtering is, I fear, practised. In branches other than those I have just referred to it is practised almost exclusively by men who have a real claim to the title of naturalist, because these branches of natural science not being so popular, there are fewer amateurs." If by this the author means to condemn museum collecting, he cannot have our sympathy. As regards the contention

that nobody should collect without fully studying the habits of the species collected, we are in full accord with Mr. Windsor; but this by no means implies that collecting, under proper restrictions, should be abolished *in toto*. Were this to be done, it is probable that young collectors would confine their attentions to stamps and such like, whereby many a promising recruit would undoubtedly be lost to science.

THE *Agricultural Journal of the Cape of Good Hope*, the official publication of the Cape Department of Agriculture, is meant to circulate among the farmers of the Colony, and contains popularly written accounts of investigations conducted by the experts attached to the Department, articles on general farming, reports on farmers' congresses, legislative enactments, and other matters of agricultural interest. The current number (vol. xxii. No. 6, June) contains plenty of evidence of the difficulties which beset the South African farmer—infectious and parasitic diseases of all kinds among his stock, insect and fungoid pests among his crops. The two most active branches of the department are evidently those dealing with veterinary medicine and insect entomology; investigations of soil and manure problems are hardly of much consequence to the Cape farmer as yet. While the greater part of this number deals with veterinary matters, we get incidental allusion to one of the questions upon which the future of South African agriculture must depend, the successful introduction of suitable forage crops to carry stock through the winter; such plants as lucerne (alfalfa) or turnips are not in the regular routine of farming, and through the winter, when there is no grass on the veldt, the animals practically starve. We learn, too, that wheat-growing, as in some of the Australian colonies, must depend upon the introduction of rust-resisting varieties; in the absence of sorts remaining rust-proof there is at present little prospect of South Africa contributing to the "Granary of the Empire."

THE geology of the Cheadle Coal-field is described by Mr. George Barrow in a handy pamphlet of sixty-two pages, with a small colour-printed map attached to it, issued by the Geological Survey. The price is 2*s*. The area is an outlying portion of the North Staffordshire Coal-field, and Mr. Barrow gives full particulars of the seams of coal, with records of borings, and remarks on the probable extent of the workable measures. The underlying Millstone Grit and overlying Bunter and Keuper formations are likewise described, and special reference is made to the water-bearing strata. Attention is also directed to the Glacial drift, to the great amount of rain-wash, and to the recent river deposits.

THE fourth part of the memoir on the geology of the South Wales Coal-field, being an account of the country around Pontypridd and Maes-têg, has been written for the Geological Survey by Messrs. A. Strahan, R. H. Tiddeman, and W. Gibson. It is issued at 1*s*. 6*d*., with a separate colour-printed map (without Glacial drifts) also priced at 1*s*. 6*d*. The map, which is very clearly printed, embraces a tract almost wholly of Coal-measures, including much of the Pennant Grit, which forms the bold moorland features of the Coal-field. Millstone Grit, and small areas of Carboniferous Limestone, as well as Lias, Rhætic Beds, Keuper Marl, and Dolomitic Conglomerate are shown on the south. Tracts of river gravel, peat, alluvium, and blown sand are also depicted. The Glacial drifts are represented on another edition of the map, which is at present hand-coloured. The memoir deals chiefly with the details of the Coal-measures, and more especially with the lower measures of the south crop, comparative sections of which are given. The upper or Llantwit measures occur only in two small outliers. The structural geology is fully described, the Pontypridd anticline and other faults and disturbances being dealt with. A study of the Glacial deposits indicates that the main ice-flow had its source in Brecknock. It followed and filled the chief valleys, but failed to surmount the Pennant Grit scarp of Carn Mosyn. Subordinate ice-flows were, however, generated on these higher regions. Economic deposits are briefly described in a separate chapter. The Pennant Grit and the Llynfi rock in the lower measures supply materials for building, paving, and road-mending. The water-supply is obtained chiefly from springs and reservoirs, seldom from wells.

A SOCIETY for spreading information about St. Michael's in the Azores has published an illustrated booklet setting forth the charms of St. Michael's as a health resort and as a station for tourists. The brochure certainly contains much interesting information about this Atlantic island.

A NEW edition, making the twenty-sixth thousand, of Miss Agnes Giberne's "Sun, Moon, and Stars" has been published by Messrs. Seeley and Co., Ltd. A new chapter, part iv. of the volume, has been added, and deals briefly with celestial photography, the planets Mars and Eros, comets and new stars, as well as other topics. With the exception of these additions, the present edition is the same as the last.

A SIXPENNY booklet describing the legends and the story of the building of Stonehenge has been received from Messrs. James Henderson and Sons. In an appendix to the pamphlet a short account is given of recent attempts to ascertain the age of Stonehenge, and a reference is made to the wire fence with which Sir Edmund Antrobus has had the ruin enclosed. This action of Sir Edmund Antrobus is characterised as wise and public-spirited, since it will help in the preservation of this valuable monument of antiquity.

WE have received a copy of the meteorological observations for the year 1902 made at the Rousdon Observatory in Devonshire, which is continued under the superintendence of Lady Peek. The publication was prepared under the supervision of Mr. W. Marriott, of the Royal Meteorological Society, and contains remarks on the weather experienced during each of the months of 1902, and a useful collection of nine tables dealing with such subjects as the pressure, temperature, and hygrometric state of the air, temperature of the soil, wind direction, rainfall, amount of sunshine, &c The concluding table affords a useful summary of the annual results for the years 1884–1902.

Two more numbers of the "Rural Handbooks" published by Messrs. Dawbarn and Ward, Ltd., have been received; one is by Mr. C. F. Townsend, and is entitled "Heating and Ventilation of Houses," the other is on "Utility Fowl Feeding and Management," and is by Mr. H. Francklin. These little books are simply written, and will serve to supply the principles upon which success in many pursuits depends. The book on ventilation is well illustrated, and contains practical information of a kind to enable any intelligent householder to secure good ventilation. The amateur poultry farmer will find numerous helpful hints in the second handbook as to how to make his hobby a profitable one.

THE current number of the *Quarterly Review* contains two exhaustive articles on subjects of scientific technology. The first is by Mr. J. Nesbit on the improvement of British forestry, and begins with a historical retrospect of the attempts made by legislation and otherwise to encourage

tree-planting and to preserve the forests. This is followed by an account of present practice and ideals. The work of the departmental committee appointed by the late Mr. Hanbury is dealt with very fully. The second article is on submarine vessels, and is unsigned. It is accompanied by four plates, and gives a full description of the attempts made to perfect this form of boat, and of the best models now in existence.

In reviewing Prof. G. P. Merrill's "Stones for Building and Decoration," when the book was first published in 1891, we cited it as affording an admirable example of the value of exact scientific knowledge when applied to the treatment of economic questions. The fact that since the date mentioned, as Prof. Merrill points out in the preface to the third edition which has now been issued, there has been a very notable increase in the output of building stone from American quarries, serves to emphasise the real connection between the scientific treatment of an industry and its success. The present edition differs from the previous ones in containing a revised chapter on methods of testing, a new chapter on the use of drift boulders for building purposes, and five maps showing the geographic distribution of the more important building stones. The new edition is published in this country by Messrs. Chapman and Hall, Ltd., and its price is 21*s*. net.

The additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Anthropopithecus troglodytes*) from West Africa, presented by Mr. H. Freeland; a Chacma Baboon (*Papio cynocephalus*) from South Africa, presented by General Sir Henry de Bathe; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. H. Baker; a Levaillant's Cynictis (*Cynictis penicillata*) from South Africa, presented by Mr. C. Marsh; an Egyptian Ichneumon (*Herpestes ichneumon*) from North Africa, presented by Dixon Bey; a Nagor Antelope (*Cervicapra redunca*), a Crowned Duiker (*Cephalophus coronatus*), a Serval (*Felis serval*), an African Civet Cat (*Viverra civetta*) from West Africa, presented by Sir G. E. Denton, K.C.M.G.; a Cuckoo (*Cuculus canorus*), British, presented by Mr. J. O. Pickington; a Back-marked Snake (*Coluber scalaris*), South European, presented by Mr. W. H. St. Quintin; a Common Toad (*Bufo vulgaris*), European, presented by Mr. H. Verrall; a Common Mynah (*Acridotheres tristis*) from India, a Chameleon Lizard (*Chamaeleolis chamaeleontides*), two Large Cuban Anolis (*Anolis equestris*) from Cuba, deposited; three Peacock Pheasants (*Polyplectron chinquis*) from British Burmah, purchased.

OUR ASTRONOMICAL COLUMN.

The Spectrum of *o* Ceti.—No. 41 of the Lick Observatory *Bulletin* is devoted to a discussion of the spectrum of *o* Ceti by Mr. Joel Stebbins.

Using the Mills spectrograph modified to a one-prism instrument, he obtained a series of twenty-five good spectra during the period June, 1902, to January, 1903, in which period the star decreased in magnitude from 3·8 to 9·0. The spectrograms were obtained on Cramer's "Crown" or "Isochromatic" plates, are 28mm. in length, and extend from λ 3700 to λ 5600.

Mr. Stebbins finds that the absorption spectrum of Mira is very different from that of the sun; the calcium lines *g*, H and K are all present, but *g* is much stronger than in the solar spectrum. From measurements of six suitable lines he found that the velocity in the line of sight is constant, with a value of +66km. A summary of the dark lines discovered indicates the undoubted presence of Fe, Va, Cr and Ca, and the Al and Sr lines are prominent, whilst the presence of Mn and Ti is as yet considered doubtful.

The general conclusion arrived at is that many of the lines become broader as the star's magnitude declines, and this is undoubtedly true of the *g* calcium line at λ 4227·84. In the later photographs some new lines, not definitely coincident with solar lines, were observed, the chief of these being λ 3990·64, λ 4045·16, λ 4093·55, and λ 4097·08.

As regards the continuous spectrum, the photographs show that as the star declines in magnitude the continuous spectrum between λ 4300 and λ 5000 decreases in intensity as compared with that between λ 4000 and λ 4300.

Amongst the bright lines the hydrogen series is undoubtedly present, although previous observers have doubted the presence of $H\alpha$, $H\beta$ and $H\epsilon$; the two latter seem to have become stronger, compared with the other hydrogen lines and the continuous spectrum, as the star became fainter. The presence of bright metallic lines is as yet open to question. In 1898 Campbell observed $H\gamma$ as a triple line, and it was intended in this research to make polariscopic tests for the Zeeman effect, but, as the line was found to be single on the first spectrograms obtained, no such tests were made.

Mr. Stebbins discusses the principal theories concerning the remarkable variation in the magnitude of Mira, and is led to the conclusion that it is due to internal forces. Numerous tables and diagrams, and several reproductions of the spectrograms of Mira, accompany the dissertation.

Photographic Efficiency of a Short Focus Reflector.—In an abstract from No. 539 of the *Astronomical Journal* Prof. Schaeberle discusses the photographic efficiency of short focus reflectors, and describes some remarkable photographs obtained by himself with a 13-inch parabolic reflector of 20 inches focus. This reflector is mounted alongside a similar one, which is used as a finder and has an aperture of 12 inches, a focal length of 46 inches, and an eye-piece magnifying 360 diameters, on an ordinary English equatorial mounting, the photographic plate ($1\frac{1}{4}'' \times \frac{3}{4}''$) being placed at the focus of the mirror.

The results obtained showed that with less than five minutes' exposure the 13-inch revealed stars which are apparently beyond the reach of the 36-inch Lick telescope, and also revealed all the stars obtained by the 3-feet Crossley reflector with two hours' exposure.

The Ring nebula just shows on plates having had four seconds' exposure, and the central star and Lassell's No. 1 star (mag. 13) plainly show on an eight seconds' exposure. These photographs disclosed the true form of the Ring nebula, showing that it is a two-branched spiral which commences at the central star, and in a clockwise direction emerges on opposite sides near the minor axis. A reproduction of a photograph, which has been enlarged 150 times, accompanies the article, and shows the details of the nebula very clearly; this photograph was obtained on October 30, 1902, with an exposure of 128 seconds.

It has been shown by the photographs obtained that, under favourable conditions and using fast plates ("Seed" No. 27), this instrument can photograph stars fainter than the seventeenth visual magnitude in less than five minutes.

The Godlee Observatory.—In a brochure issued from the printing department of the Manchester Municipal School of Technology, the principal gives a detailed description of the Grubb telescope presented to the observatory connected with the school by Mr. Francis Godlee, of Manchester.

The mounting is of the twin equatorial type, and carries an 8-inch refractor and a 12-inch Newtonian reflector, besides a 6-inch achromatic doublet intended for astrographic work.

The refractor is provided with a filar micrometer, a finely divided position circle, and the usual accessories necessary for delicate visual observations. The polar axis is fitted with two R.A. circles, one of which may be set to sidereal time and rotates with the axis, so that the R.A. may be obtained by finding the difference between the readings of the two circles. The driving of the telescopes is performed by the usual clockwork arrangements, and is electrically regulated by a pendulum having a perfectly *free* movement; the mounting is so designed as to permit the instrument to make the whole circumpolar revolution without interruption.

THE MARINE BIOLOGICAL ASSOCIATION.

THE council of the Marine Biological Association, in the report for 1902–1903, presented to the annual general meeting of the association on June 24, state that the work of the association has been considerably augmented in consequence of the fact that a commission has been accepted from H.M. Government to carry out in the southern British area the programme of scientific fishery investigation adopted by the International Conference, which met at Christiania in 1901. The work in connection with these investigations is being carried out in the southern part of the North Sea and in the English Channel. In connection with the North Sea work, a laboratory has been fitted out at Lowestoft, and the steam trawler *Huxley* has been hired. Some difficulty was experienced in obtaining a vessel suitable for the work with the funds provided by Government, but the council were fortunate in securing the assistance of one of their members, Mr. G. P. Bidder, who himself purchased the *Huxley* from her former owners and let her upon favourable terms to the association. Accommodation for the naturalists has been fitted up in the old fish-hold of the trawler, and a small laboratory has been built on deck.

The investigations in the North Sea include a scientific survey, by means of the s.s. *Huxley*, of the trawling grounds between the east coast of England and about 3° 30′ E. longitude, in connection with which observations are made on the nature of the bottom, the nature and abundance of animal life living on the bottom and serving as food for fish or otherwise, the size and weight of the fishes caught, the food of the more important fishes, the condition of the fishes as regards sex, maturity, or spawning, and the temperature of the sea at surface and bottom. A simultaneous survey is being carried out of the regular fisheries on the trawling grounds, with the assistance of reliable masters of commercial fishing vessels. Experiments are also being made on the migrations of fishes, by marking and liberating fishes in large numbers over wide areas. These experiments are designed to throw light on the extent and direction of the seasonal and other migrations of food-fishes at different stages of their growth, particular attention being paid to the migrations of undersized flat-fish, and also to give an indication of the percentage of fish on the trawling grounds actually caught by the trawling fleets from one year to another. In addition to the above lines of research, special investigations are to be made on the rate of growth, age, fecundity and racial varieties of fishes, on the abundance of floating fish-eggs, and on the variations in the size and weight of fish landed at the various fishing ports throughout the year.

Up to the middle of June the *Huxley* completed twelve scientific trawling voyages in the North Sea. More than 34,000 fishes have been measured, the animal life of the bottom has been systematically studied from the point of view of distribution, and the food-contents of about 3000 fishes have been examined and determined. Plaice have been marked and liberated in different parts of the North Sea. In November and December a number of small flat-fish were marked on the grounds west of the Borkum Reef, and the results obtained are already of great interest and importance. They indicate that during December and January there was a marked migration southwards and westwards of the small plaice previously congregated on the inshore grounds of the northern and western coasts of Holland, the distances travelled being in many cases quite unprecedented, viz. from one hundred to one hundred and sixty miles in six weeks or two months. More than 10 per cent. of the fish liberated have already been recovered.

The English portion of the international scheme of hydrographic and plankton observations, the execution of which has been assigned to the Marine Biological Association, is to be carried out in the western half of the English Channel. These investigations have for their object the study of the seasonal changes which take place in the physical and biological conditions prevailing over the entire region covered by the international programme, though more particularly directed to a study of the waters entering the North Sea from different directions. They are designed to determine (1) the origin, history, and physical and biological characters of the water found in each locality at different seasons of the year and at corresponding seasons in different years, changes in which must necessarily have a profound influence upon the distribution and abundance of the fish-life in the sea; and (2) the variations which take place in the floating and swimming organisms (plankton) which constitute the fundamental food-supply of the sea.

The investigation is being carried out (1) by means of a series of quarterly cruises made simultaneously over the whole area by the vessels of the participating countries, as a result of which a thorough knowledge, based upon the most accurate available methods, is obtained of the conditions prevailing at all depths at certain fixed stations, together with a less detailed knowledge at intermediate points; and (2) by observations, more especially of the surface conditions, at as many points as possible during the time intervening between the seasonal cruises.

Complete series of observations at twenty stations in the English Channel were obtained during the first fortnights of February and May.

The ordinary work of the association has been carried on at the Plymouth Laboratory during the year. Work on the detailed record of the Plymouth fauna has been continued, the trawling experiments in the bays on the south coast of Devon have been completed, and a considerable number of naturalists have made use of the laboratory for their special researches. The statement of receipts and expenditure for the year shows a deficit of 117*l.* 1*s.*

THE PARSONS STEAM TURBINE.

THE recent launching of the cross-channel turbine steamer, the *Queen*, to which reference was made in our issue of July 2 (p. 209), has directed attention to the efficiency of turbine engines for many purposes. An ideal engine is one which has only one rotating part, and in which the direction of movement is not varied. Engineers have for many years recognised this fact, and much time and money have been expended in their endeavour to perfect a rotary engine. No practical success was, however, attained until 1884, when the Hon. C. A. Parsons, F.R.S., placed on the market his first compound steam turbine applied to driving a dynamo. Since then Mr. Parsons has effected many and various improvements, until, at the present time, the Parsons steam turbine is recognised by engineers to be a thoroughly efficient and practical engine, which, in the larger sizes, has attained an unprecedented degree of economy in steam. In the latter few years, the Parsons steam turbine has been applied to the propulsion of ships with very satisfactory results, and bids fair, in the near future, to supersede the reciprocating engine for certain classes of vessels.

A description of the Parsons turbine was given in NATURE several years ago (vol. lxi. p. 424), with illustrations of its parts. The turbine consists of a cylindrical case with numerous rings of inwardly projecting blades. Within this cylinder, which is of variable internal diameter, is a shaft or spindle, and on this spindle are mounted blades, projecting outwardly, by means of which the shaft is rotated. The former are called fixed or guide blades, and the latter revolving or moving blades. The diameter of the spindle is less than the internal diameter of the cylinder, and thus an annular space is left between the two. This space is occupied by the blades, and it is through these the steam flows.

In the arrangement of turbine machinery as adopted in the turbine Channel steamer the *Queen*, there are three turbines, viz. one high pressure in the centre of the ship and two low pressure, one on each side of the ship. Each turbine drives a separate shaft, with one propeller on each shaft, three in all. Inside the exhaust casing of each of the low pressure cylinders a reversing turbine is fitted. In ordinary going ahead, the steam from the boilers is admitted through a suitable regulating valve to the high pressure turbine, and after expanding about 5-fold, it then passes to each of the low pressure turbines in parallel, and is again expanded in them about 25-fold, and then passes to the condensers, the total expansion ratio being 125-fold.

The *Queen* is the third passenger vessel built by Messrs. Denny and Brothers fitted with the turbine system of propulsion supplied by the Parsons Marine Steam Turbine Co.,

Ltd. The *King Edward* was the first, and at her trial in June, 1901, this vessel obtained a mean speed of 20·48 knots. The *Queen Alexandra* was the second vessel; she was built in the following year, and obtained a mean speed of 21·63 knots. Both these vessels are now running on the Clyde.

A very important feature of these turbine vessels is the economy of coal consumption. In support of this it is of interest to mention that, at the launch of the *Queen Alexandra*, Mr. James Denny stated that if the *King Edward* had been fitted with balanced twin screw triple expansion engines of the most improved type, and of such size as would consume all the steam the existing boiler could make, the best speed that they possibly could expect would be 19·7 knots, as against the 20½ knots actually attained by the *King Edward*. The difference between 19·7 knots and 20½ knots corresponds to a gain in indicated horse-power in favour of the turbine vessel of 20 per cent.

Mr. Parsons, in a paper before the Institution of Naval Architects in Dublin recently stated that "the engining of larger vessels and liners is not a very long step beyond what has already been proved to be successful. The experience with the marine turbine up to 10,000 horse-power in ships of fast as well as of moderate speed, has tended to justify the anticipation, guided by theory, that the larger the engines the more favourable will be results as compared with reciprocating engines. The saving of weight, cost, space, attendance, and upkeep will become still more marked with turbine engines of above 10,000 and up to 60,000 horse-power, for which designs have been prepared."

It may be added that the results of moderately large turbines have shown an increased economy in steam consumption of 10 per cent. to 15 per cent., as compared with the best triple expansion engine.

Among the principal advantages of the steam turbine compared with ordinary engines are the following:—complete absence of vibration from main engines; increased economy in steam and coal consumption; increased accommodation and stability of vessel owing to low position of machinery; increased safety to engine room staff, owing to absence of reciprocating parts; reduced weight of machinery; reduced cost of attendance on machinery; and reduced consumption of oil and stores.

ANTHROPOLOGICAL NOTES.

TRUSTWORTHY studies on Australian languages are still greatly needed; it is therefore with pleasure that we welcome the elementary grammar, by the Rev. N. Hey, of the language of the Nggerikudi, a tribe of some 400 natives of North Queensland in the neighbourhood of Batavia River. Although Mr. Hey has been connected with the Presbyterian Mission to these people for ten years, he does not yet quite understand all the intricacies of the language. He notes that the aboriginals are fast disappearing. The vocabularies will be of some use to ethnologists who cannot profess to grasp the structure of the language. This study forms the sixth *Bulletin* of North Queensland ethnography that the Department of Public Lands, Brisbane, is bringing out under the editorship of Dr. Walter E. Roth.

The last issue of the *Reliquary and Illustrated Archaeologist* maintains the interest of former numbers. Messrs. Miller, Christy, and W. W. Porteous deal with a selection of Essex brasses that range from the reign of Edward IV. to nearly the end of that of Charles I., that is, almost to the time when the custom of wearing armour and the practice of laying down monumental brasses were both discontinued; the illustrations show clearly the various styles of armour worn during this period, as well as the modifications in the costume of the ladies. Papers of this kind are calculated to form a valuable adjunct to the teaching of history. Mr. J. Romilly Allen describes some late survivals of primitive ornament on wooden spoons, stay-busks, and knitting-sticks which were made for the special purpose of being given away as presents from young men to their sweethearts. Mr. Arthur Watson traces the tumbler's art during the last few hundred years; it was an accessory to the banquet in the middle ages; in the sixteenth century it had risen to a position of greater importance and independence; later it entered a new phase as an accompaniment to the drama; in modern times our streets yet retain traces of the ambulatory troups of performers, and acrobatic performances are still in vogue in the circus and music-hall.

The annual report for 1901–1902 of the Field Columbian Museum, Chicago, is a record of considerable progress, even for this enterprising museum. The cost of new installation for that year was about 10,000*l*., more than half of which amount was spent on new cases. Attention is directed in the report to the unsatisfactory condition of the fabric of the museum, which, it will be remembered, was one of the admittedly temporary buildings of the World's Fair. Judging from a paragraph in *Science* for July 10, this will soon be remedied, as the park commissioners of Chicago have approved the transfer of the museum from Jackson Park to Grant Park, which is on the lake front in the centre of the city. It is understood that Mr. Marshall Field has agreed to give 1,000,000*l*. for the construction and endowment of the museum. In the department of anthropology all the collections, with the exception of two important purchases, have been derived from field expeditions, consequently they are of unusual interest and of great

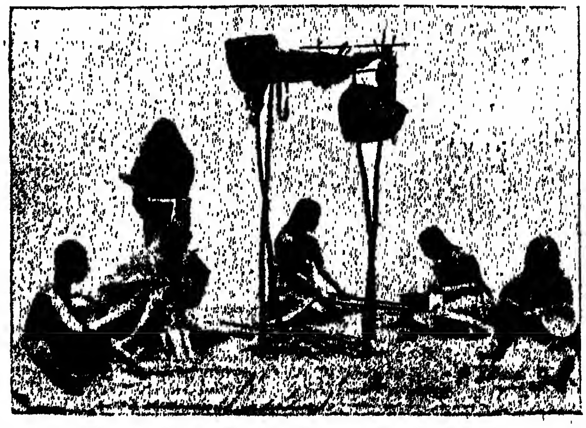


FIG. 1.—Salish House Group, Puget Sound, Washington Field Columbian Museum.

scientific importance; this is undoubtedly the most satisfactory manner of stocking a museum. The zoological collections were also augmented in a similar manner. The report is illustrated with excellent plates, which show that this museum is determined to keep the lead in the naturalistic and artistic excellence of its large animal groups. The Salish house group shown in the accompanying figure is an instructive addition to the many ethnological groups in the museum. Specifications are given of the new geological cases, and the botanist describes the reasons why he has adopted dead black labels printed with aluminium ink. Other educational aspects of the museum are its library, numerous popular lectures, and various publications. There is a very large attendance of school children accompanied by their teachers, and there can be no doubt that the schools and colleges are availing themselves more and more of the facilities of the museum as teaching adjuncts to books.

A BURIED TRIASSIC LANDSCAPE.

OUR older rocks have naturally diversified the scenery during many a past period. Bent and hardened by various processes, and ridged up into hilly ground, some of them have so long withstood the assaults of eroding agents as to have fairly earned the title of "everlasting."

This may truly be said of the buried mountains of Charnwood Forest. Visitors to that picturesoue and elevated district will have been struck with the curious rocky eminences that protrude here and there from what otherwise is a somewhat rounded, pastoral region. These isolated

barren stony tracts, with highly inclined slabs of rock and a fringe of fallen blocks, call to mind descriptions of kopjes.

Prof. Watts, in an interesting essay (*Geographical Journal*, June), shows clearly that here we have the "veritable peaks and arêtes" of a mountain system, formed of slates, hornstones, and agglomerates, with intruded syenites and granites, which jut out from a thick covering of Triassic marls, with basement breccias and sandstones.

Pre-Cambrian in age, these rocks have been subjected to various earth-movements, producing cleavage and jointing, and such intense induration that they appear to be equally strong, and the structures probably were impressed upon them in Cambrian times. Be this as it may, Prof. Watts concludes that they must have formed a mountainous tract in Old Red Sandstone times, and that then the mass was cut up by rapid streams into fiord-like valleys with ever-sharpening ridges. Some features are indicative of marine action, and it is probable that these were formed when the area was submerged in Lower Carboniferous times, and the ridges appeared as islands. After re-elevation in Permian times, subaërial waste contributed the materials of the breccias, and the conditions led on to those of the Trias, when salt-lake and desert, akin to the features of the Great Salt Lake and of Baluchistan, characterised the scene. The landscape which had been blocked out in Old Red Sandstone times, and modified in the Carboniferous period, was now subjected to much weathering, and ultimately the thick deposits of Keuper Marl buried up many, if not all, of the summits, to be partially revealed again by later denudation. Not until the Glacial period is there any positive evidence of the subsequent exposure of the ancient rocks, but blocks from the higher summits do appear in the Boulder-clay of the neighbourhood.

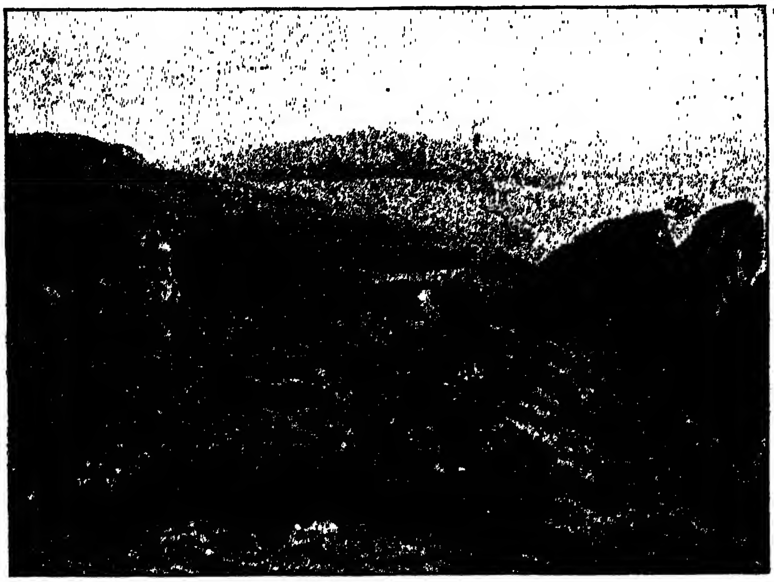


FIG. 1.—Bradgate Park, Charnwood Forest. Crags of Charnian Rock rising from Triassic ground. (From the *Geographical Journal*.)

Of the development of the present features Prof. Watts gives an interesting sketch. The Trias appears to have filled fiords which have been revealed by the present streams, and although they have deepened and altered the character of the older rocks when they excavated to them, the main outlines of the old scenery, uncovered by the denudation of the Keuper Marls, belong to the original Triassic landscape. As he points out, the granite of Mount Sorrel, when unbared for quarrying, shows often a smoothed and terraced surface, which was at first attributed to glaciation. More recently these surfaces have been found to extend beneath coverings of Keuper Marl, and the evidence is conclusive that the rounding and terracing must have been due to wind-erosion in the Triassic deserts before the peaks were buried under the Keuper Marl. H. B. W.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. Howard Marsh, surgeon to St. Bartholomew's Hospital, London, and formerly professor of pathology and surgery at the Royal College of Surgeons of England, has been elected to the professorship of surgery, which has been vacant since the death of Sir G. M. Humphry, F.R.S.

Prof. Ewing, F.R.S., has sent in his resignation of the chair of mechanism and applied mechanics, to take effect on September 30.

Mr. C. E. Inglis, King's, and Mr. A. H. Peake, St. John's, have been appointed demonstrators in the engineering department.

Mr. W. E. Hartley, Trinity, has been appointed assistant observer at the observatory, *vice* Mr. A. Graham, retired.

THE eleventh summer meeting of university extension students was opened last Saturday at Oxford, when the United States Ambassador, Mr. Choate, delivered the inaugural address, taking for his subject American university education. After describing how Harvard was founded in 1636, and referring to the rise of the other older universities in the United States, such as Yale and Columbia, Mr. Choate explained that it was found at the beginning of last century that, if American universities were to hold their own, they must greatly increase their numbers, change their methods, and assume new and closer relations with the people. At that time there were only twenty-six colleges and universities in the whole territory of the United States, and many of these were in an undeveloped state. They are now numbered by hundreds, many of them richly endowed, and most of them furnishing an adequate training, adapted to qualify youths for business and for any duty to which they may be called. These new colleges are not all on the same model, but afford a wide choice of courses of study to suit the varied necessities of a diversified community. With the exception of a few of the older States which are already well provided with them by private means, each State in the Union has, by the use of public funds and lands, created a State university; and it has been the ambition of several of their multi-millionaires to create universities by the generous application of portions of their fortunes. By this means powerful institutions of learning have been created in a few years. The University of Chicago, founded in 1892, and endowed chiefly by the generosity of one man, now numbers more than 3000 students. By far the most signal advance in university extension yet made in America is the latest in date—the creation of the Carnegie Institute at Washington—with an endowment of ten million dollars to be devoted absolutely to original research. Another reason for the success of the efforts to improve university education in the United States was brought out by Mr. Choate, who made it clear that the work of the universities, colleges, and technical schools rests on the broad and firm foundation of the common schools, which from the beginning have been the peculiar care of the people, and that educational authorities in America adhere rigidly to the theory that special study for professional or business life should be postponed until a broad and general education has developed the faculties and character. Referring to the Rhodes scholarship scheme, Mr. Choate remarked that it provides that henceforth there shall at all times be at Oxford 100 American youths selected from all the States, there to receive the best fruits of her nurture and instruction. "And now would not some rich American respond to Mr. Rhodes's challenge, and forthwith in his lifetime make a similar and equal provision for 100

young Britons—English, Scotch, and Irish—to be maintained at universities in the United States?"

THE Lord Mayor of Liverpool, Mr. W. Watson Rutherford, has received in his capacity of chairman of the university committee the charter of the new University of Liverpool. Since the publication of the first draft of the charter, a clause has been added specifying that degrees representing proficiency in subjects of technology shall not be conferred without proper security for testing the scientific and literary knowledge underlying technical considerations. Mr. Rutherford has addressed a letter to the Liverpool City Council suggesting that the new university "be directly allied with the city, and should be free," and the letter is to be considered by the council as we go to press. In his letter Mr. Rutherford says:—"Let the matriculation examination be as severe as any in the country, and let every degree remain as high a standard of knowledge as that of any university in the world; but let there be no fees, no financial barrier whatever to the poorest citizens of Liverpool obtaining all the advantages of the Liverpool University," and he goes on to point out that a maximum rate of one penny in the pound would cover the students' fees and leave a considerable margin. The letter maintains that another benefit would be a sense of proprietary interest in the university on the part of the citizens of all classes in Liverpool, who would thereby at this juncture have not only elementary, secondary, and technical instruction, but the highest regions of advanced education, placed at their free disposal, and would, therefore, be far more likely to take a keener interest in the Liverpool University. The objections that what is not paid for is not valued, and that the course proposed would discourage private munificence, are regarded by Mr. Rutherford as ill-founded. The experiment of conducting a free university in this country has not yet been tried, and should the proposal be put into practice, the results will be awaited with keen interest by all who desire the spread of higher education. At the first meeting of the council of the university held on Tuesday, Lord Derby, the Chancellor, pledged himself to the utmost of his power to help to lay the foundations of a university in which studies of the arts, science, and other subjects should receive all possible expansion. Mr. E. K. Muspratt was appointed president, and Mr. J. W. Alsop vice-president, of the university council.

THE Board of Education has published "Syllabuses and Lists of Apparatus Applicable to Schools and Classes other than Elementary" for next session, that of 1903–4. The divisions in science and art subjects other than mathematics, formerly described as Elementary Stage and Advanced Stage, are now described as Stage 1 and Stage 2, and the divisions in science subjects, formerly known as Honours Part i. and Honours Part ii., are now described as Stage 3 and Honours. We notice that the examination tables supplied to mathematical candidates have been revised, and that notice is given that the alternative Stage 1 of theoretical inorganic chemistry will probably be discontinued after next session's work. Section i. of the first stage of the hygiene syllabus has been transferred to the subjects in which the Board of Education does not hold examinations. The second part of the volume is wholly devoted to two sets of syllabuses, styled concise and detailed respectively, in a great variety of subjects suitable for evening continuation schools, but in which the Board does not hold examinations.

NEW buildings, for which the sum of 80,000*l.* is required, will shortly be erected for University College, Reading. Of this amount, 30,000*l.* has already been contributed by five donors, including 10,000*l.* given by Mr. G. W. Palmer, M.P., and 10,000*l.* by Lady Wantage. The late Lord Wantage was president of the college from 1896 to 1901.

THE "Year-book" of the Armour Institute of Technology at Chicago for the session 1903–1904 contains not only full particulars of the courses in mechanical, electrical, civil, and chemical engineering, as well as in architecture, at the College of Engineering, but also of the preliminary studies which have been arranged at the Armour Scientific Academy, where students are prepared for the more advanced work of the college. Taking into their own hands in this way the early training of their engineering students, the authorities of the Armour Institute are able to provide the professors with students possessing a sufficiently good education to benefit by the lectures.

THE issue of *Science* for June 19 reprints Prof. R. H. Thurston's address at the dedication of Engineering Hall, Iowa State College. The subject chosen is the functions of technical science in education for business and the professions, and in the course of the address Prof. Thurston pleads powerfully for the full recognition of the importance of scientific knowledge to men whose business is in any way connected with technical matters. Perhaps the part of the address which will most interest the English reader is that which deals with the employment of American students after they have left the universities or colleges. The demand for college-trained men seems to be much greater in America than it is here, the "captains of industry" in that country having apparently realised the value of sound theoretical training in those whom they put in charge of their technical manufactures. "I have a deep file of letters calling for such men," says Prof. Thurston. "There is practically none unemployed unless on the sick list. All the professional engineering schools are thus situated. Turning out a thousand or more annually, the whole output is absorbed by the great industries, and immediately upon leaving the doors of the college." Can English professors say the same?

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 28.—"On a Remarkable Effect produced by the Momentary Relief of Great Pressure." By J. Y. **Buchanan**, F.R.S.

The experiment was made first during the cruise of the *Challenger* on March 27, 1873, in lat. 21° 26′ N., long. 65° 16′ W., where the depth of the sea was 2800 fathoms, and it was repeated on board the yacht *Princesse Alice* (H.S.H. the Prince of Monaco) on March 11, 1902, in lat. 43° 8′ N., long. 19° 48′ W., where the depth of the sea was 3000 fathoms.

FIG. 1.

Fig. 1 shows the effect produced on a stout brass tube 13 inches long and 1⅝ inches in diameter, which was perfectly cylindrical before it was exposed to the momentary relief of high pressure which has produced so deep a corrugation. In Fig. 2 the corresponding effect on a copper sphere of 5 inches diameter is shown; it takes the form of a multitude of small creases in place of the single deep corrugation produced on the tube. The experiments were made on the sounding cord on board the yacht *Princesse Alice* on September 10 and 11, 1902. The brass tube contained an ordinary 50 c.c. pipette sealed up at both ends, and empty except for the air which it contained. It occupied the part of the tube which has been so disfigured, and was kept in its place by a loose packing of cotton waste. Water had free access both at top and bottom.

The copper sphere contained a small spherical glass flask of 1 to 1½ inches in diameter, and it was kept more or less in the centre of the sphere by loose cotton packing; small holes at each pole of the sphere admitted the outer water. The brass tube was attached to the sounding cord and sent

to a depth of 3000 metres. The copper sphere was sent first to 3000 metres, but with no effect, and then to about 6000 metres, when the effect shown in Fig. 2 was produced. The *rationale* of the proceeding is:—at some depth less than 3000 metres in the case of the brass tube, and less than 6000 metres in the case of the copper sphere, the glass tube in the former and the glass sphere in the latter case collapsed suddenly. Considering, for brevity's sake, only the brass tube; immediately before the collapse the pressure inside and outside the brass tube was equal and uniform. The collapse of the glass tube produced a sudden and very considerable relief of pressure inside the brass tube. In ordinary circumstances the void so produced would have been filled by water from the outside entering through the perforated ends of the tube. But as the glass tube was subjected to a pressure of nearly 300 atmospheres before it collapsed, the difference of pressure produced in a moment of time was between 200 and 300 atmospheres. The deep corrugation shown in Fig. 1 proves that it was easier *in the time* for the pressure to pinch up the stout brass tube than to shove in the plugs of water at either end. The sudden action of the pressure is due, not to the settling of the column of 2000 to 3000 metres of water on the tube, but to the resilience of the enormous quantity of water of high tension produced by the pressure under which it finds itself.

FIG. 2

The effect produced on the copper sphere when the enclosed glass sphere collapsed is of exactly the same kind.

The experiment was originally made on board the *Challenger* on the day after she made her deepest sounding in the Atlantic in the neighbourhood of the West India Islands. On that occasion both the thermometers attached to the sounding line collapsed under the enormous pressure of 3875 fathoms, amounting to 700 atmospheres, and the experiment was made with tubes of three different widths in water of 2800 fathoms in order to obtain data for the construction of future thermometers. Two of the tubes collapsed, only the narrowest, having a diameter of 6 millimetres, withstood both the pressure assisted by the shock of the others collapsing near it. In all three cases the glass tubes were converted into a fine powder like snow.

The collapse of the brass tube, in the peculiar circumstances of the experiment, is the exact counterpart of the experiment which is frequently, but unintentionally, made by people out shooting, especially in winter. If, from inattention or other cause, the muzzle of the gun gets stopped with a plug of even the lightest snow, the gun, if fired with this plug in its muzzle, invariably bursts. Light as the plug of snow is, it requires a definite time for a finite pressure, however great, to get it under way. During this short time the tension of the powder gases becomes so great that the barrel of the ordinary fowling-piece is unable to withstand it and bursts.

June 18.—"New Investigations into the Reduction Phenomena of Animals and Plants." Preliminary Communication. By Prof. J. B. **Farmer**, F.R.S., and J. E. S. **Moore**.

In this communication the authors in the first place pointed out that the attention which investigators have recently paid to reduction phenomena occurring in animals

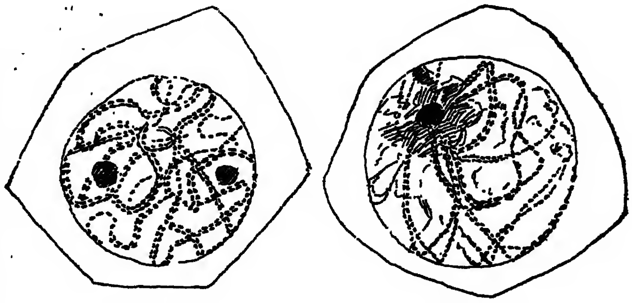


Fig. 1. Fig. 2.

and plants has resulted so far in an increasing divergence of opinion, both respecting the nature of this process and its significance. At the same time it was, however, apparent that there were several important points upon which all were now agreed; it had, for example, been clearly shown that, during this process, the number of the chromosomes occurring in the cells affected was reduced by one-half, and that this reduction was brought about during the rest preceding two cell divisions, which appeared to be invariably related to the process. Consequently it was rendered probable that the explanation of reduction was to be sought through a minute study of this, the synaptic rest phase, in a number of selected animals and plants. With this object, the authors had made a close examination of a large number of types, including mammals, elasmobranchs, amphibia and insects among animals, phanerogams, ferns and liverworts among plants, and the results of this investigation are at variance with the common existing conceptions of the process, while at the same time they seem to indicate a possible reconciliation between the different views which have been, and still are, held by other investigators. It will be remembered that there are two main theories of reduction. In the first we have the process regarded as a qualitative division of the chromatin by the separation into daughter nuclei of entire somatic chromosomes.

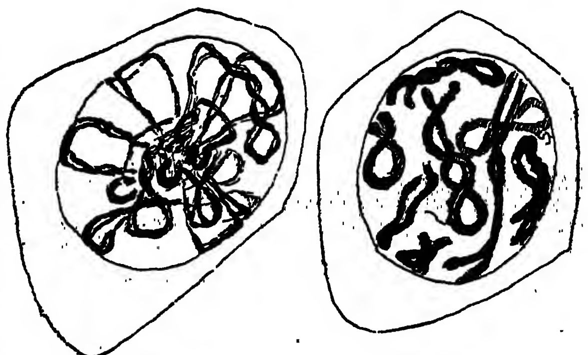


Fig. 3. Fig. 4.

In the second, the identity of the original somatic chromosomes becomes lost during the synaptic rest, and these are then replaced by half the number of new ones, which, during their formation, become longitudinally split twice in planes at right angles to each other. This double longitudinal division serves for two mitoses which take place almost simultaneously.

The authors find that at the end of the synaptic rest

the spirem thread certainly undergoes longitudinal fission. Connected with this there is a stage when the thread is arranged in loops, the split sides of which are approximated together in U-shaped figures. Although at their first formation the sides of these U-shaped loops are far apart, and still show the original longitudinal fission, they ultimately become approximated together, and at the same time the original fission, running throughout the length of the loops, disappears from general view. Through this process the approximated sides of the loops have hitherto been generally mistaken for the thickened halves of the originally split spirem thread, whereas in favourable cases it is seen that this fission can still be traced running along both sides of the loops.

The number of these loops arising during the synaptic rest corresponds to the reduced number of the chromosomes, and the further process in the formation of these chromosomes is simply a thickening and shortening of the loops already formed. When these become divided during the next mitosis they break transversely at a point corresponding to the original bends of the loops, and as the halves thus severed separate, the original longitudinal fission can be clearly traced running along their entire length. It is thus this original fission of the spirem thread, which serves to distribute the halves of the disunited somatic chromosomes during the following homotype division, and the hitherto enigmatical figures described by Flemming Meyès and others in the diaster of the heterotype find their natural explanation.

It would thus appear that the synapsis and the so-called heterotype mitosis constitute a phase which has been specially intercalated in the reproductive cycle. In it the reduction in the number of the chromosomes is produced by their adhesion in pairs, and the completion of the original longitudinal fission of the spirem thread is deferred until the following homotype mitosis.

The authors purposely refrain from discussing the general bearing of these observations, reserving this for a further and more detailed communication.

PARIS.

Academy of Sciences, July 27.—M. Mascart in the chair.—The preparation and properties of a silicide of ruthenium, by MM. Henri **Moissan** and Wilhem **Manchot.** At the melting point of ruthenium this metal combines with silicon with ease, giving a silicide of the formula RuSi, of density 5.40, perfectly crystalline, possessing great hardness, and very stable in the presence of most reagents.—Arsenic in sea-water, in rock-salt, kitchen salt, mineral waters, &c. Its determination in some common reagents, by M. Armand **Gautier.**—On dividing waves, by M. P. **Duhem.**—On cyclohexane and its chlorine derivatives, by MM. Paul **Sabatier** and Alph. **Mailhe.** The authors have shown that the aromatic nucleus really persists in the hydrocarbon; the vapour of cyclohexane directed alone on to recently reduced nickel maintained between 270° and 280° is regularly decomposed, [illegible] benzene and hydrogen, which at this temperature reacts on the benzene, transforming it into methane, $3C_6H_{12}=2C_6H_6+6CH_4$. The presence of the aromatic nucleus is also proved by the reactions of the chloroderivatives. One monochlorocyclohexane, two dichloro-, three trichloro-, and one tetrachloro-cyclohexane are described.—Photograph of Borrelly's comet, 1903 *c*, by M. **Quénisset.** The photograph was taken at the Nanterre Observatory on July 24–25, with an exposure of one hour. The photograph shows that the coma measures 16′ in diameter, that is, a little more than half the apparent diameter of the moon. Several tails can be distinguished, the most luminous and longest of which is at least 7° 50′ in length.—On the conditions of synchronisation, by M. **Andrade.**—On the measurement of the dichroism of crystals, by M. Georges **Meslin.**—On the electrical dichroism of liquids containing crystalline particles in suspension, by M. J. **Chaudier.** With the advice of M. Meslin, who has examined the modifications produced in ordinary light by its passage through a liquid containing crystalline particles and placed first in a magnetic field and secondly in an electric field, the author has continued the experiments with other mixtures in an electric field. A certain number of the mixtures presented a decided dichroism, which took a certain time to appear and disappear after the discontinuance of the field. The liquids which entered into the composition of the active mixtures usually contained no oxygen. No direct relation seems to exist between the chemical properties of the solid and the electrical dichroism it is able to cause when associated with a suitable liquid.—On the separation of gaseous mixtures by centrifugal force, by MM. G. **Claude** and E. **Demoussy.**—On the laws and the equations of chemical equilibrium, by M. **Aries.**—On a combination of two bodies which unite as a result of an elevation of temperature then separate below −79°, by M. D. **Gernez.**—Separation and simultaneous determination of baryta, strontia, and lime, by M. Lucien **Robin.**—On the condensation of ethers with alcohols, by M. Ch. **Moureu.**—On the composition of allyl cyanurate, by M. R. **Lespieau.**—Contribution to the study of the quinones-diketones, by M. **Œchsner de Coninck.**—Albuminoid substances in Indian corn, by MM. **Donard** and **Labbé.**—The use of a calorimetric bomb to demonstrate the presence of arsenic in the organism, by M. Gabriel **Bertrand.** With camphor or pure sugar no trace of arsenic was obtained, but a few grams of tortoise-shell, of sponge, of the white or yolk of an egg, gave clear indications of arsenic.—Influence of temperature on the production of sulphuretted hydrogen by albuminoid substances, extracts of animal organs and extracts of yeast, in the presence of sulphur, by MM. J. E. **Abelous** and H. **Ribaut.**—Researches on the natural immunity of vipers and snakes, by M. C. **Phisalix.**—On the spermatogenesis of decapod crustaceans, by M. Alphonse **Labbé.**—Artificial production of gigantic larvæ in an Echinoid, by M. F. A. **Janssens.**—Inscription of the variable state of the tension of the wire of the ergograph: equation of the movement and expression for the work, by MM. A. **Imbert** and J. **Gagnière.**—On the production of gum in tissues, by M. G. **Delacroix.**—On the trenchings of the plain of Sevran, by M. Gustave F. **Dollfus.**—On a new physical method of research and of the determination of the watering of wines, by M. Georges **Maneuvrier.**

CONTENTS. PAGE

THURSDAY, AUGUST 13, 1903.

THE UNIVERSITY IN THE MODERN STATE.

V.

SINCE the earlier articles under the above heading appeared, the views we have attempted to express touching the importance of universities in the lives of States and even of Empires from a national or political, as well as from an academic point of view, have been strengthened in a remarkable manner by the inauguration of a new movement in relation to the universities of the British Empire.

The important departure to which we refer is due to the initiative of Sir Gilbert Parker, and was recently discussed at a conference in London, at which official representatives, specially approved by every one of the governing bodies of degree-conferring universities throughout the Empire, including Canada, Australia, New Zealand, and the Cape of Good Hope, as well as the home institutions, were present. By the kindness of one of the delegates we were enabled to give an account of what took place at the time. The publication of a full account of the proceedings, which has now appeared in the *Empire Review*, enables us to enter into some details.

One of the most important and interesting announcements made during the meeting, showing how much may spring from a closer union of university with other national aims, was made by Sir John Buchanan, the Vice-Chancellor and delegate of the Cape of Good Hope University, who reported that the first step to the union of the different States of South Africa had been accomplished by the Cape University, which this year, for the first time, had conducted its examinations in each of the five States of South Africa at the request of the Governments of the several States.

Now that this conference has taken place, we are in a position to gauge its importance. There is no question that a movement has been begun which is bound to go on from strength to strength; which, if the committee appointed does its work thoroughly, will bring all information bearing upon our university organisation together, and so enable a levelling up process to go on. Nothing is more distressful in English history than the way in which, since the introduction of scientific processes into modern civilisation, our schools and universities, for want of proper endowment for the new learning, have failed to provide the scientific spirit and the brain power which are now recognised as the most important weapons in a nation's armoury, and with which, to our detriment, the competing nations are now so fully equipped.

The Prime Minister in his admirable speech at the inevitable dinner left no doubt as to the origin of our present backwardness. While properly pointing out that the collective effect of our public and secondary schools upon British character cannot be overrated, he frankly acknowledged that the boys of seventeen or eighteen who have to be educated "do not care a farthing about the world they live in except in so far as it concerns the cricket-field or the football-field or the river." On this ground they are not to be taught science, and hence, when they proceed to the university, their curriculum is limited to subjects which were better taught before the modern world existed, or Galileo was born.

The first great result of the conference was the distinct recognition of the importance of arrangements for the mutual benefit of all the academic bodies in the Empire, and this complete agreement is all the more satisfactory at a time when the question of fiscal arrangements is dividing the country into two hostile camps. Again, the absence of such academic arrangements at present was shown to be detrimental. Unlike the fiscal problem, therefore, on the proper discussion of which much time may be spent, the university problem may be tackled at once, and we need not delay to profit by any benefits it may bring.

The resolutions passed at the conference were as follows:—(1) In the opinion of this conference it is desirable that such relations between the principal teaching universities of the Empire should be established as will secure that special or local advantages for study, and in particular for post-graduate study and research, should be made as accessible as possible to students from all parts of the Empire. (2) That a council consisting in part of representatives of British and colonial universities be appointed to promote the objects set out in the previous resolution, and that the following persons be appointed a committee to arrange for the constitution of the council:—Lord Kelvin, Lord Strathcona, Mr. Bryce, M.P., Mr. Haldane, M.P., Sir William Huggins, Sir Michael Foster, M.P., Sir Oliver Lodge, Sir A. Rücker, the Rev. Dr. Mahaffy, the president of Magdalen College, Oxford, the president of Queens' College, Cambridge, the Hon. W. P. Reeves, and Sir Gilbert Parker, M.P.

One of the most important matters raised in connection with the first resolution was the value of the education imparted in the British universities in relation to those of other countries. Sir John Buchanan told the conference that they were endeavouring at the Cape to send their best graduates abroad for further training, "and it was much to be regretted that at present those students could not always get what they sought for in the mother country."

In the United States, where the university system is more complete and far better endowed than with us, the students who wish to go afield for further study do not come to Britain, they go to Germany or France, and before we can expect colonial students to come to the mother country exclusively, our university system will require to be brought up to date, which can only happen when many millions are available for proper endowments, in other words, when the principle of State endowment already accepted has been effectively acted upon.

If one effect of the conference is to bring this home to the minds of those who have to deal with such matters, it will have already accomplished an important work when as great freedom and facility for study and research can be obtained within the King's dominions as are available elsewhere.

That the facilities referred to by the colonial university authorities included ample means for the prosecution of original research was made perfectly

clear, and to this part of the inquiry Prof. Ewing contributed a most important statement as to the educational value of research as demonstrated by his experience at Cambridge. We may hope that at least after thirty years' debate this matter can be considered settled. In the language of our correspondent, "Since Germany has given to our disadvantage a definite experimental proof of the success of research as an instrument of education, the delegates probably felt that the matter had gone beyond the range of academic discussion."

When once this idea of the proper function of universities is re-established and in full operation, not only at Oxford and Cambridge, but in many other British universities, it may happen that not everybody will agree with Mr. Balfour's comparisons between the old and the new seats of learning.

"I daresay that many of us have looked back with a certain regret, and a certain feeling of shame, to the medieval passion for learning without fee and without reward—with no desire to make the universities stepping-stones to good places or to successful mercantile or industrial undertakings—but with an ideal which made thousands of students from every country in Europe undergo hardships which would be regarded in these softer days as absolutely intolerable, for the sole purpose of seeking, and it might be finding, the great secret of knowledge. We despise, and we perhaps rightly despise, their methods. We know that they were not in touch with the actual realities of the world in which they lived. Yet, after all, we have something to learn from them; and if we in these days could imitate their disinterested passion for knowing and for extending the bounds of knowledge, surely we, with our better methods, and our clearer appreciation of what we can know and what we cannot know, might accomplish things as yet undreamed of. Now, what did they do? They moved from university to university, from Oxford to Paris, from Paris to Padua, from country to country, in order that they might sit at the feet of some great master of learning, some great teacher who might lead their thoughts into undreamed of paths. I hope that in the universities of the future every great teacher will attract to himself from other universities students who may catch his spirit—young men who may be guided by him in the paths of scientific fame; men who may come to him from north or from south."

We agree as to the facts as to the past, but it is not the carelessness and greed of the modern student that are in question, but rather the decadence of our universities, which are no longer seats of learning in the old sense, that is, they do not supply the knowledge most useful to those who attend them in relation to the needs of the time. They are chiefly conducted as playgrounds for the sons of the rich, learning is too little endowed, and great teachers are too little encouraged, especially in the matters in which the modern world is concerned.

If only students of science found at our universities of to-day what students of theology, law, medicine, and *les trois langues*, found in the old time at all universities, that is, perfect teaching, and the endowment of research at the university itself, things might be righted, and, as of old, many fitted for the battle of life would go out into the world to apply their knowledge as did their forerunners, and show neither more nor less "disinterested passion" than the well paid ecclesiastics, lawyers, and doctors of the past.

It is because the universities of Germany, France, and the United States, aided by wisdom and endowments, conform to the old ideal, while our ancient ones remain as *hauts lycées*, as Matthew Arnold called them, and our modern ones are crippled for want of funds, that the students of both Britain and Greater Britain find an advantage in going abroad to build up their brain power.

It is to be hoped that as a result of the conference the educational federation of the Empire will some day be brought about. It must not be forgotten that the first step in this direction was taken when the Royal Commissioners for the Exhibition of 1851 founded its research scholarships, in which every university in the Empire has a share—a share which it has fully used, and with the best effects. That other similar scholarships should be founded by the different Governments and private individuals may be one of the results of the conference.

Our plea for better brain power for the nation was not lost sight of in the deliberations, and we may fitly conclude by the following quotation from a speech by Mr. Haldane, which brought the discussion to a close.

"To-day we are a step further on towards doing that which, as a people, as the great English-speaking people, we need more than anything else. We have got the splendid energy of our race, we have got the power which is ours, in a unique degree, of adapting ourselves to new conditions, of overcoming difficulties which to others might even seem to be insurmountable, and yet we have been deficient in the capacity of organisation. What we have lacked in this country, somehow, has been the thinking faculty, and it is the work of education to develop the thinking faculty in a nation. And never before was the thinking faculty so much needed as to-day when the weapons which science places in the hands of those who engage in great rivalries of commerce leave those who are without them, however brave, as badly off as were the dervishes of Omdurman against the Maxims of Lord Kitchener."

THE SPECTROSCOPE IN ASTRONOMY.

Problems in Astrophysics. By Agnes M. Clerke Pp. xvi+567. (London: A. and C. Black, 1903.) Price 20s. net.

THE triple alliance of astronomy, physics and chemistry has extended the boundaries of each in unexpected directions. Astronomy is no longer a dependency of mathematics, but an independent power having a high place in the hierarchy of the physical sciences; instruments of research in physics have been turned from earth to sky, and chemistry now looks to the stars for evidence as to the distribution and ultimate structure of the elements.

The spectroscope is the chief means by which these new territories have been gained for science and explored, and the photographic plate has not only been its faithful scribe, but has also gained distinction as an astronomical artist. Individually and jointly, the prism and the camera have increased our knowledge of the nature and number of all classes of celestial

objects. The general study of the solar spectrum has given way to investigations of the sun in detail; and spectrum analysis now not only reveals the constitution of the stars, but measures their movements with an exactitude impossible by any other means. The light of nebulæ has been shown to be but the manifestation of molar activity having a vastly greater sphere of influence than that suggested by the visible limits; and nebulæ themselves, from being regarded as a peculiar class of celestial bodies, have been linked to stars and shown to be the amœbæ in a scheme of inorganic evolution.

The story of this development is related by Miss Clerke in the exuberant style with which all readers of astronomical literature are familiar. The first part of her book, occupying about one-third of the whole, is devoted to the sun, and the remainder to sidereal physics. Among the subjects of chapters in the former part are peculiarities of the solar spectrum, the reversing layer, the spectrum of sun-spots, the chromospheric spectrum, the sun's rotation, and the solar cycle. The forty-one chapters of the second part deal with many varieties and characteristics of stars and nebulæ, the subjects including helium stars, carbon stars, the spectra of double stars, rotation of the stars, spectroscopic binaries, dark stars, star clusters, nebulous stars, variable nebulæ, the nature of nebulæ, and the physics of the Milky Way.

For the collection and analysis of contributions to the study of these and other problems in astrophysics, Miss Clerke merits the thanks of astronomers. As is the case with every branch of science in its youth, questions arise much faster than they can be answered, and it requires a fine critical faculty to separate results of transient value from those of significance to scientific progress. The historian has to decide what things matter and what may be neglected when considered from the point of view of their influence upon development; and success is achieved when this power of discernment is combined with insight which enables the relationship to be seen between cause and consequence.

With the best desire in the world to give Miss Clerke credit for her work, we must confess to a feeling that it is not altogether satisfactory. In the first place, the net which she has used in her explorations of astronomical literature is of too fine a mesh, so that she has gathered in results and ideas which ought to have been discarded as being of little value, or immature. Next, as we shall show later, she has not understood the real nature of some of the material collected; and finally, she passes judgment and gives advice on matters which can only be rightly understood by investigators actively engaged in spectroscopic work.

A man who has had a scientific training can quickly grasp the essential points of progress in any branch of natural knowledge if they are brought before his notice, but he will rarely venture on criticism of results, or lay down the lines of further research unless he has a personal and practical acquaintance with the subject. Miss Clerke does not always exercise the same caution, with the result that she sometimes labours the obvious. Her function as an historian is to assimilate and describe, and when she is exercising her talents in this direction she is at her best. She surveys the work from the point of view of the spectator, and should describe fairly and clearly what she sees, without irritating the men who are doing the work by expressing her opinion upon it or suggesting what course they ought to take next. In other words, she should remember that "Passengers are respectfully requested not to speak to the man at the wheel."

In preparing a statement of the position of fact and theory in any branch of science, great care must be exercised, and not a single assertion should be made without substantial reason for it. A cynic has said that it is a characteristic of women to make rash assertions, and in the absence of contradiction to accept them as true. Miss Clerke is apparently not free from this weakness of her sex. Referring to the line 1474 K she says (p. 117):—"Eclipse-spectrographs do not include it, while they have afforded some other quite unexpected results." An examination of spectrum photographs of the eclipses of 1893, 1896, and 1898 would have shown Miss Clerke that 1474 K is included in all of them. There are other instances in which statements of an *ex cathedra* character are made without a full appreciation of the facts. Thus, the identification of a "dozen and upwards" chromospheric lines in the spectra of krypton and xenon (p. 120) is doubtful, to say the least; and the Stonyhurst origins referred to on p. 187 in connection with the spectrum of γ Cassiopeiæ are in the same case. Again, in the table of nebular lines on p. 477, the line at λ 4122 has a note of interrogation placed after the word helium indicating its origin, though there is practically no doubt that the line is helium λ 4121. Moreover, the line λ 4715, said to be of origin "unknown," is really the helium line λ 4713.3.

It is in such matters as these that Miss Clerke shows she is not a working spectroscopist possessing an intimate acquaintance with the subjects she describes. The result is that she is led to pass unsound judgments, and to be satisfied with an imperfect record of the facts available. Thus, on p. 48, in considering the relation of the chemistry of the chromosphere to the depth she quotes a paper by Mr. S. A. Mitchell, but makes no reference to the Royal Society report on the 1893 eclipse, where a full discussion of the conditions is given. Again, for evidence of the existence of more than one gas in the solar corona reference is made (p. 131) to a paper by Mr. S. J. Brown, but a note on the discussion of the photographs of the 1898 eclipse, presented to the Royal Society and published in the *Proceedings* (vol. lxvi. p. 189), is not mentioned, though it shows that three groups of lines, indicating three gases, are recognisable in the corona spectrum.

Miss Clerke demurs to the late Prof. Rowland's conclusion that there is no fundamental difference between solar and terrestrial chemistry. "*Quantitative*, if not *qualitative*, dissimilarity must," she believes, "be recognised"; and she instances titanium among other elements which are clearly represented in the solar spectrum, and yet are scarce here. Titanium is more widely distributed than Miss Clerke supposes, but, even if it were extremely rare, her

suggestion as to the relative amounts of this and other elements existing in the sun and earth is misleading. Remembering that nothing is known of the chemical constitution of the earth a few miles below the surface, it is possible that rare elements in the crust may be abundant nearer the centre. The differences between solar chemistry as manifested by the solar spectrum, and terrestrial chemistry as represented by mineralogical knowledge, are therefore only apparent, and Rowland was justified in his remark, "were the whole earth heated to the temperature of the sun, its spectrum would probably resemble that of the sun very closely."

The distinction between spark and arc spectra is not sufficiently recognised, with the result that unsound judgments are sometimes reached. A case of this kind occurs in connection with the discussion of the chromospheric spectrum. The green line of the chromosphere is coincident with one of the members —due to iron—of the triplet known as Kirchhoff 1474 in the Fraunhofer spectrum. Miss Clerke says:—

"Now the chromospheric ray agrees in position with the iron line, which is one of secondary importance; yet it cannot at present be asserted confidently that it really emanates from glowing iron vapour. If it did it should be ordinarily associated with other iron lines, and none have been ascertained to make part of the fundamental chromospheric spectrum."

If the spark spectrum of iron had been considered instead of the arc spectrum, these remarks would, we think, have been modified. The iron line at 1474 K is not of secondary importance in the spark spectrum; indeed, the fundamental chromospheric spectrum consists largely of iron lines—not the ordinary lines of the arc spectrum, but lines such as those at $\lambda\lambda$ 1474 K, 5018, 4924, 4584, and 4233, which are enhanced in relative importance in passing from the arc to the spark.

In connection with the subject of the temperature of the stars, the behaviour of lines of magnesium at different temperatures is referred to. Other conditions being the same, the magnesium line 4352 becomes finer with increase of temperature, while that at 4481 becomes thicker, and this opposite behaviour provides a test of increasing or decreasing temperature. But it is not pointed out that the test must be applied with caution; for the line 4352 in the spectra of hot stars is not due to magnesium, but is really an enhanced line of iron. If 4352 in the hot stars were a magnesium line, then other lines of the same series ought to be present, but they are not.

The chapter on new stars is characteristic of a large part of the book. Details are given of observations of new stars from Nova Aurigæ to Nova Persei, but the record can scarcely be described as complete, and the chief lesson taught by Novæ is overlooked. Many years ago, Sir Norman Lockyer expressed the view that "new stars, whether seen in connection with nebulæ or not, are produced by the clash of meteor swarms." When this conclusion was arrived at, few precise observations of the spectra of Novæ were available, but it is not too much to say that visual and photographic inquiries made since then into the phenomena of new stars have substantiated it in a very remarkable manner. By the meteoritic hypothesis, new stars approximate to nebulæ as they fade, until their light at the last stage is indistinguishable from that of a nebula. This association of new stars with nebulæ is now an accepted fact, but the consequences have not been so clearly acknowledged. As a new star reverts to the condition of a nebula when it cools, evidently nebulæ are not masses of gas at transcendental temperatures. Just as in biology, the course of evolution is traced in the development of the embryo, so we may consider that in its brief life a new star passes in some respects through the various stages which mark the growth and decay of worlds.

The spectroscopic history of Nova Aurigæ was a surprise to astronomers, who regarded the meteoritic interpretation of the phenomena of new stars as a hypothesis of doubtful validity. For, though there might be a difference of opinion as to the meaning of the displacement of the bright and dark lines in the spectrum, there could be none on the fundamental fact that the Nova became a planetary nebula, both visually and spectroscopically, as it sank into obscurity; and this course of events was precisely that previously found to have been exhibited by new stars which had been subjected to spectroscopic analysis. Rarely has hypothesis received such decided confirmation, but Miss Clerke does not even mention the paper in which it is put forward. The history of several new stars is concluded with words to the effect that "the regular cycle had been run through: a planetary nebula replaced the faded star," but there is no reference to the analysis of spectroscopic records before Nova Aurigæ, which showed that the reversion to a nebular type is a common characteristic of new stars.

The case of Nova Persei is of even greater significance from the point of view of cosmogony than that of Nova Aurigæ, for its light revealed the existence of vast areas of dark matter in interstellar space. Miss Clerke describes the vicissitudes through which the object passed, and the apparent expansion of the nebula associated with it. With regard to this phenomenon we read:—

"An explanatory hypothesis of considerable plausibility was hit off independently by Prof. Kapteyn and Mr. W. E. Wilson.[1] It affirms the nebula to have been pre-existent, and to remain unchanged. But since we see it by the unchanged light of the Nova, its various spires and condensations have come successively into view as the flare of the explosion travelled outward in widening circles. Hence an illusory effect of radial expansion was produced, while in point of fact, the temporarily illuminated cosmic folds were as immovable as aligned snow-peaks, in turn set aglow by the setting sun."

In other words, cosmic dust, or meteoritic particles, or dark nebular matter—whatever you care to term it—existed in the part of space in which the new star made its appearance. The fundamental idea of the meteoritic hypothesis is here accepted, and its application to the phenomena of new stars acknowledged. Astronomers have, in fact, been driven to the belief in the existence of sheets or streams of non-luminous matter in space; and dark nebulæ, as Prof. Turner has termed them in an article in the *Fortnightly*

[1] NATURE, January 30, 1902.

Review, are no longer considered hypothetical, but as real as dark stars.

A new class of celestial bodies has thus been brought under notice, and Miss Clerke does not sufficiently appreciate its significance. This, however, is a matter of opinion, but surely for the sake of historical completeness she might have mentioned that the association of nebulæ with new stars was first put forward in the meteoritic hypothesis. She is careful to give credit in most cases, but in connection with Nova Persei no reference is made to the fact that Sir Norman Lockyer first suggested in these columns that the dark nebula existed before the star appeared. In the issue of December 12, 1901, he wrote:—

"It is impossible to think that the great nebula which has now been photographed while the new star is still in being did not exist there a few months ago; and it is important, further, to remark that the nebulous matter already photographed in the region round the Nova is very probably only a portion of the actual amount of matter existing there, and that if the disturbances continue, more of the remaining portion may become visible."

Here we have a definite statement of the pre-existence of the dark cosmic matter in the neighbourhood of Nova Persei before the new star became visible, but it has been overlooked by Miss Clerke. This is to be regretted because, a few years hence, astronomers will be just as interested in knowing how the idea of dark nebulæ passed from hypothesis to demonstration as we are in Bessel's discernment of the existence of dark companions of Sirius and Procyon before these bodies came within the sphere of astronomical discovery.

One other point connected with Novæ is worth mention. In the description of the spectrum of Nova Aurigæ it is stated that "an exceptional feature was the predominance of 'green' helium; D_3 and the rest of the lines belonging to the 'yellow' set were comparatively faint; while λ 4922, λ 5016 and their fundamental λ 6678, shone lustrously." An unnecessary difficulty is raised in the attempt to account for the appearance of these lines in the Nova spectrum; for the first two lines mentioned were really not due to helium, but were enhanced lines of iron at λ 4924 and λ 5018. This identification does not rest solely upon these two lines, for other enhanced lines of iron appeared in the spectrum of the Nova.

Other details upon which there are differences of opinion might be mentioned, but no useful purpose would be served by doing so. In directing attention to the various points referred to in the foregoing remarks, the object has been to show that, though Miss Clerke writes with exceptional facility and grace, she is not an infallible guide, and has a tendency to works of supererogation. Notwithstanding this, we do not hesitate to say that, by writing the record of astrophysics, she has done a great service to astronomers. Her book makes it possible to obtain a view of the chief fields in which astronomical inquiries are now being carried on, and of the achievements which have been reached. To readers interested in the progress of knowledge relating to the sun, stars and nebulæ, whether they are laymen, or men of science so deeply engrossed in other investigations that they have not been able to keep in touch with astronomy, the book will be a revelation. Those who are engaged in the work of astrophysics will be saved many hours of tedious research among scientific books and papers by this chapter from the history of science.

R. A. GREGORY.

THE GERMINAL LAYERS OF THE VERTEBRATA.

Furchung und Keimblattbildung bei Tarsius Spectrum. By A. A. W. Hubrecht. Pp. 115 + plates. (Amsterdam: Müller, 1902.)

EMBRYOLOGISTS will certainly unite to congratulate Prof. Hubrecht on the completion of this memoir. To have obtained and figured a complete series of developmental stages of any animal is in itself no mean achievement, but when this animal is one of the rarest of mammals, procurable only in a distant quarter of the globe, we may well wonder at the persevering patience which has succeeded in overcoming difficulties which, to an ordinary worker, would have been insurmountable.

Tarsius has always been regarded as a member, though a very aberrant member, of the Lemuroidea. The embryological evidence which has now been brought before us is practically conclusive in favour of its removal from this suborder. The placentation is most pronouncedly of the so-called "deciduate" type, while the arrangement of the fœtal membranes, with the diminutive yolk-sac, rudimentary allantois, and large extra-embryonic cœlomic space, is identical with that found in man and monkeys, but nowhere else.

The placenta, and the important changes leading to the formation of the "Bauchstiel"—so long a puzzle to human embryologists—have already been the subjects of two publications by Prof. Hubrecht. In the present treatise we are introduced to the processes of maturation, fertilisation, segmentation, the histology of the formation of the amnion, and, above all, to the germinal layers.

First to appear are the above-mentioned extra-embryonic cœlom and the yolk-sac. The material for the former springs from the posterior end of the blastoderm. In continuity with it is formed the primitive streak in the centre of which is the rudimentary blastopore or neurenteric canal. The mesoblast, however, is also formed from an anterior tract of hypoblast (as frequently in Amniotes) and from a peripheral ring (as described by the author in Sorex).

These facts, admirably illustrated by a very complete set of figures, form the basis for some very bold speculations. The germ layers of the Vertebrata have proved a stumbling-block to many an embryologist. The solution of the problem here proposed (due originally to van Beneden, and first expounded in Oxford) is one which cuts all the old ground from under our feet. We are taken back, not to Amphioxus, or even to an Annelid, but to a Cœlenterate, and asked to see in the gastrovascular cavity and stomodæum of this, the latest ancestor of all the Vertebrates, the forerunners of the blastopore and notochord respectively Such a theory involves the assumption that the

archenteron communicates with the segmentation cavity in all Anamnia, which is hardly the case; on the other hand, it seems to get over the difficulty of deriving the conditions found in the Amniotes from those observed in lower forms.

We imagine, however, that few morphologists will accept so imaginative an hypothesis. It is not difficult to explain the differences between these two great divisions of the Vertebrates more logically by reference to the Gymnophiona. But putting that aside, it is open to grave doubt whether it is possible to attach any phylogenetic significance, any morphological value in the determination of homologies, to the germ-layers of the Vertebrates, or, indeed, of any other group. Their significance is rather physiological, and can only be analysed by the ordinary physiological methods of observation and experiment.

PSYCHOLOGICAL STUDIES.

Harvard Psychological Studies. Vol. i. Edited by Hugo Münsterberg. Pp. 654. (New York: The Macmillan Company, 1903.)

THIS, the fourth volume of monograph supplements to the *Psychological Review*, consists of sixteen papers by the students of the Harvard School of Psychology, fifteen of which represent the principal results of the work done in the laboratory in the last few years. Most of the papers show, properly enough, the influence of Prof. Münsterberg's vigorous and original mind, and it is no doubt owing in part to his teaching and direction that each of the researches deals with a well-defined problem by appropriate and original methods. But the individual workers have preserved their independence, and the standard of treatment and achievement reached is in all cases a high one.

Of six studies in perception, Mr. Holt's explanation of the bands seen on passing a rod across the surface of a rapidly rotating disc bearing coloured, or black and white, sectors, is an admirable example of neat and convincing experiment. Of three studies in memory, those of Messrs. Meakin and Moore are interesting as achieving valuable results by systematically conducted introspective observation of the primary memory-image. Even the "purest" and most old-fashioned psychologist could hardly raise objection to their procedure. Their results suggest that much valuable knowledge is to be gained by those who have the patience to follow up this line of research, but the absence of all objective control of the results makes the method a dangerous one, unless subjects innocent of psychological theory can be found to carry out the introspective observations.

Of four studies in æsthetic processes, the principal are elaborate and ingenious researches on the constitution of objective rhythm-forms and on symmetry. In the case of the latter, the experimental conclusions are supported by analyses of pictorial compositions ranging from the ornamental designs of primitive people to the altar-pieces of Raphael. In two studies in animal psychology, Mr. Yerkes breaks new ground by registering accurately the reaction-times of the leg of the green frog in response to a variety of stimuli, and he shows that the frog and the crayfish are alike capable of learning by experience, of acquiring new associations, though but slowly; he thus refutes the view that they are but unconscious automata, a view that has been based on the belief that they are devoid of such capacity.

The volume is completed by a short paper in which Prof. Münsterberg briefly restates the main conclusions reached in his "Grundzüge der Psychologie" (Leipzig, 1900). He claims that under the term psychology two fundamentally different sciences are commonly confused together; the one treats of "the inner life as objective content of consciousness, as phenomenon, the other of the inner life as subjective attitude, as purpose." The former science is descriptive and explanatory, those who pursue it are "phenomenalists"; the psychical objects with which they deal are abstractions, comparable to the physical objects dealt with by the physicist. The other science, improperly called psychology, is "voluntarism"; it is teleological and interpretative, but not explanatory, it includes the normative and historical sciences, and gives "a more direct account of man's real life than psychology can hope to give." These remarks prepare the way for a comprehensive tabular classification of all the sciences, which, whether it be found acceptable or no, is certainly novel and extremely interesting.

W. McD.

OUR BOOK SHELF.

A Gloucestershire Wild Garden. By the Curator. Pp. xii+230. (London: Elliot Stock, 1903.) Price 6s. net.

GARDENING books are becoming noted for containing a small amount of gardening information largely diluted with something that has little or no relevance to horticultural pursuits. The diluting medium may be cookery or hygiene, tirades against vivisection, stale jokes, spiritualism, anything, in fact. In the present book gardening, or one phase of it, represents the slices of bread between which are inserted, sandwich-fashion, dissertations on the molecular structure of the brain and nerve centres, and discussions on the origin of thought and the nature of religious impressions.

The "Curator" is the gardener who evidently knows plants and loves them. To him appear when he is tired of work, or, at any rate, without preface or apology, a somewhat prosy "Professor," who supplies the anatomical details above mentioned, and explains them from the materialistic standpoint, and an orthodox "Padre," who is somewhat shocked at the views propounded by the professor. The Curator acts as moderator, and when discussion seems likely to become dangerous, suggests a pipe of tobacco or a cup of tea as effectual "shunters." At any rate, we pass abruptly from metaphysical subtleties either to the tea-table or to another chapter, in which we are told how to construct a "wild" garden. As if all this were not enough, a love story—a very short one—is introduced, and so the book has one quality which a garden should possess, and that is, variety.

The author tells us that he does not write for critics, but we hope he will not mind our saying that the gardening part of his book is on a higher level than that to which we are accustomed in similar books, and as for the remainder, we should prefer in this Journal not to express any opinion, but to leave the reader to form his own conclusions.

Geographen-Kalender. In Verbindung mit Dr. Wilhelm Blankenburg, Prof. Paul Langhans, Prof. Paul Lehmann, und Hugo Wichmann, herausgegeben von Dr. Hermann Haack. Erster Jahrgang, 1903–1904. (Gotha: Justus Perthes, 1903.)

THIS is the first issue of what is likely to prove an indispensable work of reference to geographers of all nationalities, as it gives in a compact form a mass of information on the yearly progress of geographical science in all its branches, besides containing much information of a statistical kind which will be of use to the general public no less than to the expert. Although, perhaps, as is but natural, the greatest amount of attention is given to German work, the book possesses a decidedly international character, account being taken of the most important work done by geographers throughout the world. A set of general tables, &c., for purposes of reference is followed by sections on the main events of the year with a bearing on political geography, on the progress of exploration, the geographical literature of the year, and so on.

A striking feature is the attention paid, in a special section from the pen of the general editor, to the progress of geographical education, though in this, more than any other section, the attention is focused on German work, hardly anything being said as to the steps lately taken in other countries to improve the position of geography in the school and college curriculum. Thus, when speaking of periodical publications devoted to this object, Dr. Haack makes no mention of the *Journal of Geography*, published in the United States, or of the *Geographical Teacher*, the organ of the Geographical Association in this country. From a purely practical point of view, a most useful section is the very complete "Adressbuch," which gives the names and addresses of geographers of all nationalities, with a brief statement of their special lines of study or research. The little book, which is most tastefully got up, concludes with an excellent series of maps illustrating the principal geographical events of the past year.

Biological Laboratory Methods. By P. H. Mell, Ph.D., Director of Alabama Experiment Station, Professor of Geology and Botany, Alabama Polytechnic Institute. Pp. xii+321; 127 figs. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1902.) Price 6*s*. 6*d*. net.

THIS is a well-conceived and eminently useful book, which within convenient compass and in clear language gives an account of microscope and microtome, staining and mounting methods, photomicrographs, and so on. It begins at the beginning, and expounds with simple accuracy the various instruments and methods of the well-equipped biological laboratory. After describing the microscope and the microtome and their accessories, the author discusses, in successive chapters, fixing, imbedding, staining, mounting, and drawing. Five chapters are devoted to photomicrography, and others follow on bacteriological methods, special methods (*e.g.* decalcification, injection, maceration and polarisation). The book ends with useful formulæ and tables, and with an appendix on laboratory furniture. We have tested the book as to various points, and have found it practical and lucid in every case. It is in part a compilation of hundreds of duly acknowledged useful hints and recipes from workers all over the world, but it also expresses the work of one who has faced detailed difficulties in actual practice and overcome them. We have come across many illustrations of American neatness and ingenuity which were fresh to us, and we confidently recommend the book as a worthy companion to Bolles-Lee's *vade mecum* and similar works.

Ijain; or, the Evolution of a Mind. Pp. ix + 207. *Isola; or, the Disinherited.* Pp. xv + 153. By Lady Florence Dixie. (London: The Leadenhall Press, Ltd.)

THESE are youthful productions of a versatile writer, whose object is to spread the truth about everything at whatever cost. "Ijain" traces the development of the mind of an unusually thoughtful child, and "Isola" is a drama, the object of which is to secure greater freedom and fuller opportunities of work for women.

LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Radio-active Gas from Bath Mineral Waters.

PROF. J. J. THOMSON has shown that the air extracted from Cambridge tap-water and from the waters of certain deep-level springs is mixed with a radio-active gas (NATURE, vol. lxviii. p. 90). It appeared of special interest to determine whether such a constituent existed in the hot mineral springs of Bath. Samples of water direct from the King's Bath Spring have been examined at the Blythswood Laboratory, and have been shown to contain a radio-active gas in solution. In the first experiments the gas was expelled from a flask containing a litre and a half of water by boiling under a pressure of about half an atmosphere. The amount of gas obtained after passing through a number of drying tubes was small, as was shown by the fact that the pressure only altered by a few centimetres. Yet this was sufficient to produce a marked increase in the ionisation in the testing vessel. The gas was also extracted from the water by exhausting the testing vessel and allowing a current of air to bubble through the water and a series of drying tubes into the vessel. In this case the ionisation current increased from four to five times.

Whichever method was employed for introducing the gas into the testing vessel, it was found that the effect did not assume its full value instantaneously, but gradually increased to a maximum and then diminished. The activity reached a maximum in rather more than one hour after the admission of the gas. About half an hour later the activity had diminished to one-half the maximum value. Rutherford (*Phil. Mag.*, v. p. 448, 1903) has observed a similar effect when the emanation from radium is introduced into a closed space. In this case the maximum activity is reached after five or six hours, and the activity decays to half value in 3·71 days. The gas from the Cambridge water lost from 5 to 10 per cent. of its activity in twenty-four hours. The gas from the Bath water appears to be intermediate in character between the radium emanation and the Cambridge gas on the one hand, and the thorium emanation on the other. The activity of the thorium emanation diminishes to one-half in one minute.

If the therapeutic action of the Bath waters is due in any degree to the radio-activity of the gases contained in them, the fact that the activity of the gas now being investigated begins to decrease so soon after the gas has been liberated acquires special significance. The opinion is commonly held that the waters of various spas possess greater efficacy when used on the spot. It is probable that this opinion, though doubtless fostered by interested individuals, has some basis in fact, and it is possible that the underlying fact may here find an explanation.

Prof. Dewar has shown that the Bath waters contain helium. The presence of a radio-active and of an inert gas in the same water is of interest from the point of view of the possible transmutation of such elements.

Blythswood Laboratory, Renfrew. H. S. ALLEN.

THE SOUTHPORT MEETING OF THE BRITISH ASSOCIATION.

SINCE the publication of the first article on the approaching meeting of the British Association (July 9, p. 224), the following additional arrangements have been made :—

Sir George Pilkington will give a garden party to 100 members at his residence, Belle Vue, Southport, on Monday, September 14. Mr. William Vernon will give a garden party to 100 members at Wyborne Gate, Birkdale, on Tuesday, September 15.

An exhibition of meteorological and magnetic instruments, diagrams, books, &c., will be held in the laboratory and lower corridor of the Science and Art Schools, immediately adjoining the reception room. The exhibition, owing to the presence of the International Meteorological Committee in Southport, is likely to be of unusual interest. Exhibits are promised by the Royal Observatory, Greenwich; the Solar Physics Observatory; the Meteorological Office; Kew Observatory; the Scottish Meteorological Society; the Royal Meteorological Society; Captain Wilson-Barker; the Scientific Instrument Co., Cambridge; Mr. W. H. Dines; Prof. Pernter; Dr. A. L. Rotch; Captain Creak; Dr. Mill; the Radcliffe Observatory, Oxford; Mr. C. T. R. Wilson; Mr. J. Aitken; Mr. Joseph Baxendell; and Mr. Halliwell.

A loan museum of objects of local scientific and archæological interest is being organised.

The printing of the "Handbook" is now complete. The contents are as follows:—(1) "Southport: Historical and Descriptive"; (2) "Southport as a Health Resort," by Dr. J. J. Weaver and Dr. A. V. Wheeler; (3) "The Meteorology of the Southport District," by Joseph Baxendell; (4) "The Geology of the Southport District," by Harold Brodrick and Edmund Dickson—(a) "The Ribble Estuary," by Edmund Dickson; (5) "The Botany of the District," by W. H. Stansfield and Henry Ball—(a) "A note on *Hypopitys Monotropa*," by Henry Ball, (b) "The Mosses of the District," by J. A. Wheldon, (c) "The Hepaticæ of the District," by J. A. Wheldon; (6) Zoology—(a) "Protozoa-Foraminifera," by Dr. G. W. Chaster, (b) "Lepidoptera," by F. N. Pierce and J. R. Charnley, (c) "Coleoptera," by Dr. G. W. Chaster and E. J. Burgess Sopp, (d) "Araneæ," by Dr. A. R. Jackson, (e) "Mollusca," by Dr. G. W. Chaster, (f) "Marine Fauna and Fisheries," by Prof. W. A. Herdman, F.R.S., and Isaac C. Thompson, (g) "A Note on the Vertebrate Fauna of the District"; (7) "Martin Mere and its Antiquities," by Harold Brodrick; (8) "Archæology," by Willis Brunt; (9) "Sketch of the Life and Works of the Rev. Jeremiah Horrocks," by G. Napier Clark.

The Cambridge Scientific Instrument Company will fix a Callendar temperature recorder in the reception room, the instrument being connected electrically with a thermometer suitably exposed to the air outside the building.

The committee of the British Association appointed at Belfast for the investigation of the upper atmosphere by means of kites will, if possible, show the working of the kite apparatus during the meeting of the Association at Southport, in illustration of the experiments carried out by Mr. W. H. Dines, under the auspices of the Royal Meteorological Society and of the British Association, with the aid of grants of money from the Association and from the Government Grant Committee of the Royal Society. The committee hoped to have the advantage of the services of an Admiralty vessel for a sufficient period to include the meeting at Southport, for, in compliance with the request of the Royal Society, the Lords Commissioners were good enough to assign a vessel for the experiments, but unfortunately she met with an accident at Devonport and sank in the harbour. She is consequently not available. The local committee of the British Association is trying to assist the committee to obtain a steamer for the purpose of carrying out the experiments at Southport.

The title of Dr. J. S. Flett's lecture to working men on Saturday, September 12, is "Martinique and St. Vincent: the Eruptions of 1902," with lantern illustrations.

The railway companies, as before stated, will issue tickets to Southport available from September 8 to 18 inclusive, but in the case of the Irish railways the tickets will be available from September 7 to 19 inclusive. The committees of the principal clubs have agreed to extend the privilege of honorary membership to non-resident members of the Association during the week of the meeting.

The Saturday afternoon excursion to Hoole and Rufford will take the form of a motor-car run. More than twenty cars have been placed at the disposal of the committee by their owners, and it is hoped that this excursion will be a popular one. Tea will be served at Rufford Old Hall. The excursion to the Wirral Peninsula is specially intended for geologists and botanists, and geological and botanical parties will be formed in connection with the Windermere excursion.

A specially prepared plan of the town in colours will be inserted in the local programme, and a plan of the Municipal Buildings, where most of the meetings of the Association will be held, will also be included.

A list of those members who had intimated their intention of being present at the meeting up to July 14 has been printed, and can be obtained at the local office. The following names of foreign and American corresponding members, and members of the International Meteorological Committee, are included in the list:—Prof. G. S. Atkinson, Cornell University, U.S.A.; Dr. Von. Bebber, Hamburg; Dr. R. Billwiller, Zurich; Prof. Ludwig Boltzmann, Vienna; M. Teisserenc de Bort, Paris; Captain Chaves, St. Miguel, Azores; Mr. W. Davis, Cordoba, Argentine; Prof. G. Gilron, Louvain; M. A. Gobert, Brussels; the Comte A. de Gramont, Paris; Prof. Hellman, Berlin; Prof. H. Hergesell, Strassburg; Prof. H. H. Hildebrandsson, Upsala; Prof. Lignier, Caen; Prof. C. Lombroso, Turin; Dr. T. P. Lotzy, Leyden; Mr. G. G. MacCurdy, Newhaven, Conn., U.S.A.; Prof. E. Mascart, Paris; Prof. H. Mohn, Christiania; Prof. Willis Moore, Washington, U.S.A.; Prof. Simon Newcomb, Washington, U.S.A.; Prof. L. Palazzo, Rome; Prof. Paulsen, Copenhagen; Prof. J. M. Pernter, Vienna; Dr. A. L. Rotch, Blue Hill Observatory, Mass., U.S.A.; General Rykatcheff, St. Petersburg; Prof. M. Snellen, Utrecht; Prof. R. H. Thurston, Cornell University, U.S.A.; Dr. H. C. White, University of Georgia, U.S.A.; Prof. E. Zacharias, Hamburg.

The Mayor of Southport (Mr. T. T. L. Scarisbrick) has issued more than a hundred invitations to members of the Association and to distinguished foreigners who will be present in Southport to a dinner at his residence, Greaves Hall, Banks, on Wednesday, September 16, to meet Sir Norman Lockyer, president of the British Association, and Prof. E. Mascart, president of the International Meteorological Committee.

The Southport Literary and Philosophical Society, which was responsible for the preliminary negotiations which resulted in the holding of this year's meeting of the Association at Southport, has arranged to hold the opening meeting of its winter session on Thursday, September 17. On this occasion Prof. A. R.

Forsyth, F.R.S., has consented to deliver an address on "Universities: their Aims, Duties, and Ideals." Invitations have been issued to many members of the British Association, as well as to others interested in educational work.

THE CENTENARY OF HEIDELBERG UNIVERSITY.

ON August 5–8 the University of Heidelberg celebrated the centenary of its re-establishment. The university, one of the oldest universities of the modern world, was originally founded in 1386 by the Palsgrave Ruprecht I. of the Palatinate. At that time Heidelberg was the seat of the princely residence and capital of this wealthy State of the middle ages, and the young university did good work from the point of view of those times. The "German Medici," Otto Heinrich (1556), delivered the university from the chains of scholastic pedantry and inspired in her the ideas of the Renaissance and of the Reformation. The thirty years' war had a disastrous effect on this town and its university, as, indeed, it had on all Germany; nevertheless, the Elector, Karl Ludwig (1650), again gave it a short period of prosperity. But with the year 1685 commenced for the Palatinate and the university a long period of sorrow and loss.

Soon the positions held by broad-minded inquirers and teachers were occupied by imperfectly educated members of Catholic Orders, and the university sank to a mere confessional school. Scientific research degenerated into the school-divinity of the middle ages, appointments were given by those in control to their relatives, and very strict tests in matters of faith were imposed.

The result was that, during the eighteenth century, scarcely any work of scientific value was done by the university, and the number of students sank to a minimum. The condition of affairs was made still worse by the loss of the income hitherto derived from the possessions on the other side of the Rhine, which were then in the hands of the French.

Though the Bavarian Prince, into whose hands Heidelberg had fallen in 1799, commenced to break the dominion of the monks, and though he sought to procure new incomes for the impoverished university, her renovation was really the work of the Badish Prince, Carl Friedrich.

By the division of Germany in 1803, Heidelberg came into the possession of the Elector, Carl Friedrich, who later became the Grand Duke of Baden. Without delay, he commenced to re-establish the Heidelberg University, to give to her a broad constitution resting on high ideals, and last, but not least, to procure the necessary money.

He endowed the university with an annual sum of 50,000 florins, which had to be raised by the State. He reserved to himself the office of "Rector" of the university, a charge which since that time has rested in the hands of the Grand Dukes. The essential principle of the reorganisation is to be found in the rule that "the professors' chairs shall be filled by the most worthy competitors, without any consideration of their religion."

The names of the first professors of that time are still well known. I only recall the names of the theologians Daub, De Wette, Paulus, the jurists Thibault and Zachariae, the physician Naegele, and the philosophers T. H. Voss, Creuzer, and Bökh. It is the centenary of this reorganisation that the university has just now celebrated.

Indeed, what these beginnings promised, the nineteenth century has seen fulfilled, and the university has taken her place among the foremost of the world. Excellent scientific laboratories, observatories, and hospitals have been built, a monumental library-building is in the process of construction, and the first modest annual endowment of 50,000 florins has grown to one of 800,000 marks, to which has been added a regular special grant, amounting in the budget of 1902–03 to almost exactly a million of marks, so that at the present time about 65,000 pounds sterling are expended annually upon the university.

If one remembers that Baden has about two millions of inhabitants, and that it possesses not only one, but three universities (Heidelberg, Freiburg, and the Karlsruhe Polytechnicum), it must be confessed that a great work has been accomplished. The number of professors and *docents* of the Heidelberg University is now 151, that of students 1884.

The work of the university during the nineteenth century has received the acknowledgment of educated men all over the world. The development of the history of Christianity is connected with the Heidelberg names, Hitzig, Ulmann, Rothe, Schenkel, and Holsten; lawyers and political economists appreciate fully the influence of Vangerow, Windscheid, Bluntschli, Mittermaier, Renaud, and Knies; physicians will remember the names of Chelius, Pfeuffer, Arnold, and Gegenbaur. The names of the philosophers Hegel and Zeller are known far and wide. Well known, too, are the philologists Koechly, Ribbeck, Wachsmuth, Zaugemeister, and Bartsch, and the historians Schlosser, Häusser, Gervinus, and Treitschke. The mathematicians Hesse and Fuchs, and the leaders in natural science, Hofmeister, Kekulé, Kopp, and above all, Bunsen, Kirchhoff and Helmholtz, have spread the glory of Heidelberg over the world.

The greatest credit for the success of the Heidelberg University in the past century must be attributed to the Grand Duke Friedrich, now seventy-six years old, who—during the fifty-one years in which he has been Rector—has made the university what she is to-day.

In the evening of August 5 the students formed a torch-light procession in honour of the Grand Duke. The next morning, after a festival divine service, the Actus was held in the Aula of the university, where the Grand Duke, the Minister, the deputations of other universities and corporations, and the acting Prorector of the university (Prof. Czerny) delivered addresses. After a banquet a reception was given by the city in the poetical ruins of the celebrated Heidelberg Castle.

On August 7 the historian of the university (Prof. Marks) gave a historical address, concerning the development of the scientific life of the university during the past century. In the evening the students held their great "Commers."

The announcement of the *honoris causa doctores* took place next morning. In the branch of medicine the following men of science were elected:—M. T. H. Dunant, Geneva; Prof. Sv. Arrhenius, Stockholm; Sir W. Ramsay, London; Prof. P. Lenard, Kiel; G. Schweinfurth, Riga; G. Moynier, Geneva.

In the branch of natural science the following were elected:—Mathematics, M. G. Darboux, Paris; physics, Dr. R. T. Glazebrook, London; astrophysics, Sir William Huggins, London; chemistry, Prof. S. Cannizzaro, Rome; mineralogy, Prof. F. Fouqué, Paris; astronomy, Prof. E. C. Pickering, Cambridge, U.S.A.; zoology, Prof. E. Maupas, Algiers; botany, A. Cogniaux, Nivelles.

In the evening of August 8 a reception was given by the Grand Duke and the Grand Duchess at their castle in Schwetzingen. Sunday, August 9, was devoted to excursions in the neighbourhood, and at night an illumination of the castle, and a great display of fireworks on the Neckar, brought the festivities to a close.

The present generation has expressed by these splendid meetings that it appreciates highly the benefit

resulting from the reorganisation of the university by Carl Friedrich, and the work done by the scientific men of past generations, and has indicated how it hopes that, in the century just begun, the development will not cease but continue, that new successes will be achieved by the more and more unrestrained unfolding of all intellectual forces, and that these successes may help to brighten the minds of the people, and to connect them more and more by the bridges of science, notwithstanding political boundaries. M. W.

BRITISH MEDICAL ASSOCIATION SWANSEA MEETING.

THE seventy-first annual meeting of the British Medical Association was concluded at Swansea on July 31. It will be remembered that last year the meeting was held at Manchester, and although as was *a priori* to be expected the numbers at Swansea fell short of those at Manchester, yet nevertheless the meeting will always live in the memory of those who attended it as an unqualified success.

The president this year was Dr. Griffiths, of Swansea, and in an excellent opening address he touched upon many points of interest and importance both to the profession and to the public. Not the least interesting of these to the readers of NATURE was the president's reference to the much discussed question of hospitals for paying patients. Sooner or later the very serious attention of the profession, and most probably also of the Government, will have to be directed to this question. An increasing number of patients requiring skilled medical or surgical treatment, such as they cannot obtain at their own homes, is occurring among a class the financial position of which, while being such as to render them the unethical recipients of charity, yet nevertheless is not adequate to meet the charges of private nursing homes. From the point of view of the economist, it seems truly absurd that this class cannot be catered for.

Another point of interest in the president's address was the repetition of the great want of complete remodelling of the Public Health Government Department. The need for something in this country corresponding to the German Gesundheitsamt has from time to time been emphasised in these columns. Numerous departmental committees appointed by various departments, the minutes of reference to which, however, have all borne directly upon the public health, have embodied in their reports a specific recommendation to this effect. Stress has also been laid upon the inadequacy of the present Governmental machinery for dealing with the important questions which modern technical industry and knowledge, using these terms in the widest sense, are apparently intermittently, but actually constantly, forcing into public hygiene. The policy adopted by the different departments of State concerned has heretofore been one of empirical opportunism. When a question has been sufficiently acute a Departmental Committee has been appointed and a report of this kind issued, often after considerable lapse of time; with the exception of notices at the time of its appearance in the Press, this report and its recommendations are often never heard of again. This policy, although it may have the effect of saving the salaries of permanent officials, cannot in the present state of the question continue long, and we are pleased to see that it was brought prominently before the greatest professional organisation which exists, viz. the British Medical Association.

The address in medicine was delivered by Dr. F. T. Roberts, the subject chosen being infective and infectious diseases. The lecturer dealt chiefly with the influence which new scientific method has exercised upon the diagnosis and treatment of disease. The scientific methods considered were essentially those which have been introduced as a result of increased knowledge of pathology, comprising under this term chemical pathology and bacteriology. These sciences, true to their name, have been without doubt most ancillary to medicine, but their very helpfulness may in itself be a source of danger in so far as concerns the progress of our knowledge of the treatment and diagnosis of disease. These new methods have a tendency, according to the lecturer, to be studied and pursued at the expense of the purely clinical ones. Students, in short, are apt to spend too much time in the laboratory and too little in the wards. An interesting part of the address was devoted to the question of the use of alcohol as a therapeutic agent; in this connection we heartily recommend the remarks of the lecturer to all interested in this question. There can be no doubt that under certain conditions therapeutics possesses no more valuable agent; most clinicians, as the result of their experience, are enabled to maintain that numerous lives have been saved by the skilful administration of alcohol; but, on the other hand, it is equally true that the seeds of future intemperance have not infrequently been sown by the indiscriminate and indefinite instructions, or rather want of instructions, which often accompany the ordering of alcohol by the practitioner of medicine. Too much care cannot be exercised in the prescribing of a remedy so potent both for good and evil.

The address in surgery was delivered by Prof. Mayo Robson, who took for his subject the evolution of abdominal surgery during the last third of a century. The address practically confined itself to the enormous development which has taken place in this branch of the healing art during the above time. In conclusion, the lecturer remarked that the future progress of surgery will probably be intimately bound up with the work of the physician, the pathologist, and the bacteriologist, and the time will come when preventive measures will save much operative work.

Much good work was done at the meetings in the different sections, though apparently no papers of very striking original interest were communicated. The social arrangements left little to be desired, the profession at Swansea and the neighbourhood extending a very hearty welcome to the visitors. Many, no doubt, made the Association meeting at Swansea the starting point of their holidays, and we have little doubt that the mental food ingested there will in many cases be assimilated on the charming holiday grounds of Wales. F. W. T.

VENTILATION OF FACTORIES AND WORKSHOPS.[1]

ABOUT three years ago, Lord Ridley, when Secretary of State for the Home Department, appointed a committee consisting of Dr. J. S. Haldane, F.R.S., and Mr. E. H. Osborn, engineering adviser to the Chief Inspector of Factories, to inquire into and report upon the means of ventilation in factories and workshops, with especial reference to the use of fans and the use and construction of respirators for the protection of workpeople exposed to dust or dangerous fumes.

In the report before us the committee deals with a portion only of the question upon which it was directed to make inquiry. It is for the present mainly concerned in the attempt to strengthen the

[1] "First Report of the Departmental Committee appointed to inquire into the Ventilation of Factories and Workshops; with Appendices." (London: Eyre and Spottiswoode, 1903.)

hands of the Secretary of State in prescribing a standard of sufficient ventilation for factories and workshops based upon what it deems to be an adequate objective criterion of what constitutes reasonably "sufficient" ventilation, viz. the proportion of carbonic acid in the air. Looked at from the point of view of the Inspecting Department of the Home Office, it was necessary, at the outset, to determine whether it was practicable to make use of this proportion as a legal standard of "sufficient" ventilation, or whether such estimations, if made with the requisite accuracy, might not prove to be both expensive and troublesome.

Determinations of atmospheric carbonic acid are mainly carried out on the principle first made use of by Dalton and worked out by Hadfield, that is, absorption of the carbonic acid contained in a known volume of the air by a suitable alkaline solution, the amount so absorbed being ascertained by volumetric analysis. This process was first extensively applied by Pettenkofer, and is generally known by his name. With proper precautions it is capable of a very high degree of accuracy, and, indeed, practically all our knowledge concerning the distribution of carbonic acid in the atmosphere, whether in the free air or in inhabited places, has been obtained by its means. The apparatus needed is somewhat bulky on account of the necessity of using large volumes of air in cases where the amount of carbonic acid is relatively small, as in ordinary atmospheric air. At the same time, when it is merely necessary to determine whether the air of an inhabited room or that of a factory or workshop contains an excess of carbonic acid over the quantity that could reasonably be prescribed as an official limit, vessels holding a couple of litres would suffice for most purposes. It would be readily possible to put together for the use of inspectors a Pettenkofer "kit" which should be light and not too bulky, and would enable the estimation of carbonic acid to be carried out rapidly and with approximate accuracy.

The committee recommends *inter alia* that the limit of carbonic acid should be fixed, except on very foggy days, when no tests should be made, on account of the vitiated state of the outside air, at 12 volumes of carbonic acid per 10,000 of air, and that when gas or oil is used for lighting, the proportion should not exceed 20 volumes after dark or before the first hour after daylight, the only exception to this rule to be in cases where the extra carbonic acid is produced in other ways than by respiration or combustion, as in breweries, &c. It is further recommended that arrangements be made by the Factory Department of the Home Office for the analysis, by a specially qualified person or persons, of samples of air collected by inspectors, and that any analysis on which a prosecution immediately depends should have been performed by such qualified person or persons, and also that arrangements should be made for inspectors of factories to have the use, when desired, of a properly tested portable apparatus for estimating on the spot the proportion of carbonic acid in air.

Dr. Haldane has devised an apparatus for the use of inspectors of factories, a specimen of which has been submitted to us for examination by Messrs. Müller, Orme and Co., of 148 High Holborn, and this seems to fulfil all the necessary conditions. A description of it constitutes appendix iii. of the report before us. The estimation of carbonic acid is made by measuring the contraction in the volume of the air to be tested by bringing the air in contact with a 10 per cent. solution of caustic potash or soda. As the volume of the air taken for the test is only about 20c.c., it is evident that special provision needs to be made, and great care in manipulation needs to be exercised if even approximate accuracy is aimed at. It is impossible in the absence of the diagrammatic representation of the apparatus which accompanies the report to explain the details of its construction, or to make clear the successive steps in its manipulation. We have had, however, an opportunity of making a number of experiments with it, and we are able to state that the amount of carbonic acid in the air of an inhabited room may be quickly ascertained, with sufficient accuracy, by means of it. An intelligent manipulator who understood the scientific principles involved would be able to obtain results accurate to within about one part in 10,000 with air containing ordinary proportions of carbonic acid, and to about two parts with air so highly vitiated as to contain, say, from 30 to 50 volumes of carbonic acid per 10,000. A trained gas analyst would, no doubt, obtain more accurate results. A determination is made in a few minutes when once the apparatus is put into working order.

Whether experiments of this kind should be entrusted to those factory inspectors who have had no training in physical science is perhaps open to question.

One possible source of considerable error was indicated during the experiments. After standing several days the potash solution used in the apparatus was found to be coloured yellow, doubtless from the action of the alkali upon the rubber tubing of the apparatus. Any sulphur thus dissolved would form alkaline sulphides which would absorb oxygen from the air under experiment, and so vitiate the result. As a matter of fact, the figures given when the apparatus was in this condition were wholly untrustworthy.

The following experiments may be cited in illustration of the degree of accuracy which may be obtained:—

I. *Experiments on the air of a laboratory.*

		Results. CO_2 per 10,000 of air.
	1st experiment.—At about 9.45 a.m., before any burners were lighted	5·0
2 or 3 Bunsens burning during the whole time of these experiments.	2nd. About twenty minutes later	5·9
	3rd ,, ,, ,, ,, than 2nd	6·3
	4th ,, ,, ,, ,, ,, 3rd	7·3
	5th ,, ,, ,, ,, ,, 4th	7·0
	6th ,, ,, ,, ,, ,, 5th	7·4
	7th ,, ,, ,, ,, ,, 6th	8·0

II. *With air containing* 24·4 *volumes of* CO_2 *per* 10,000.

1st experiment	23·3
2nd ,, ...	21·7

III. *With air containing* 45·2 *volumes* CO_2 *per* 10,000.

1st experiment	42·3
2nd ,, ...	41·6

GRAHAM BELL'S TETRAHEDRAL CELL KITES.

IN the June number of the *National Geographic Magazine* is a very interesting and instructive article by Dr. Graham Bell on the tetrahedral principle in kite structure. The article itself is so concise, and depends so much upon illustrations which are reproduced to the number of twenty in the text and seventy in an appendix, that an effective representation of the contents in an article of smaller dimensions is scarcely possible. Still the line of thought that runs through the work which the article represents is so clear and so suggestive that even an imperfect outline of it may be useful. Dr. Bell indicates certain stages in the development of his ideas as "milestones" of progress, and since the ultimate stage of the development is the possibility of building up very large kite structures by combining unit cells in such a way that the proportion of weight to wing area in the structure

is nearly the same as that of the constituent cell, the successive stages are noteworthy. They sketch out in a most interesting manner a reply to Newcomb's criticism of the limits of application of the aëroplane based upon the argument that increase of size means diminished efficiency because, for similar structures, the weight varies as the cube while the area, upon

FIG. 1.—A Winged Tetrahedral Cell.

which the lifting force depends, varies as the square of the linear dimensions.

The original stage, the ordinary kite, is a single plane structure. The first step in advance is the Hargrave box kite, with its upper and lower aëroplanes for its support, and side planes for stability. To stiffen the framework of the box kite it must be braced longitudinally and transversely; accordingly Graham Bell's development commences by replacing the rectangular framework of the box kite by a framework of triangular section which is by construction

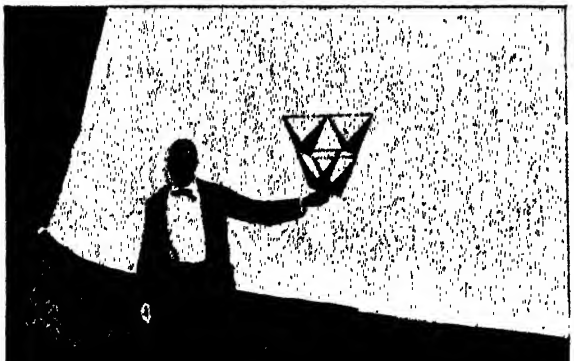


FIG. 2.—A Four-celled Tetrahedral Kite.

stiff so far as the cross section is concerned. The inclined sides are by the vector principle of resolution of forces regarded as equivalent to their geometrical projections, and, in so far as the principle applies, the inclined faces represent the combined effect of aëroplanes of the area of the projections.[1]

[1] This principle to be generally applicable would require the normal component of wind pressure to be uniform and independent of the angle between the plane and the wind. This is not the case with an aëroplane (see Rayleigh, NATURE, vol. xxv. p. 108); and for the principle to be applied approximately in the case of the kites some convention as regards the angle of exposure of the aëroplanes to the wind would be required.

The box kite of triangular section is, however, not stiff as regards longitudinal shear, and the next "milestone" marks the reduction of the triangular or prismatic form to the tetrahedron, an essentially stiff framework for all directions. A tetrahedron of rods with two adjacent faces covered with fabric forms a tetrahedral kite cell which, on the principle of projec-

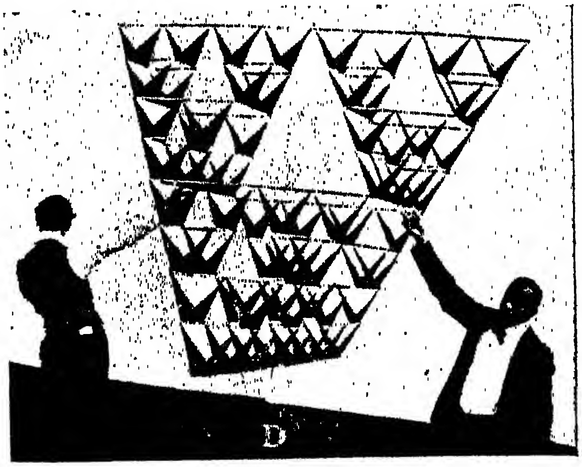


FIG 3.—A Sixty-four celled Tetrahedral Kite.

tion before referred to, is equivalent to three aëroplanes represented by the projections of the covered sides upon planes at right angles.

The further development of pure tetrahedral construction is obvious. Four cells can be combined to form a tetrahedron of double linear dimensions without additional framework; the weight and wing area are both simply proportional to the number of cells, and not to the linear dimensions. For each set of four cells thus combined there is an octahedral free space in the interior which corresponds to the free space between the two cells of the Hargrave kite. The tetrahedral

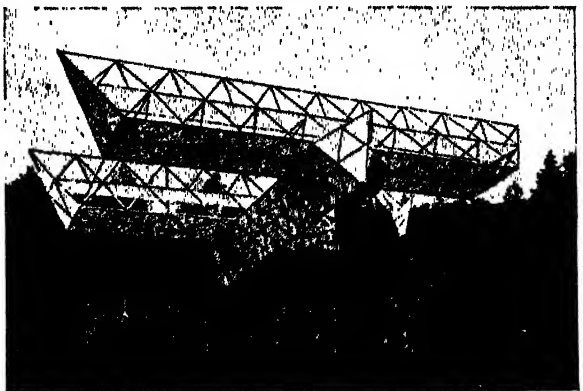


FIG. 4.—The Aërodrome Kite.

kites that have the largest central spaces preserve their equilibrium best in the air.

Combining four multiple cells to fill the outline of a tetrahedron of double size, again, we get a sixteen-cell kite, and repeating the process again a sixty-four cell kite, occupying a tetrahedron eight times the dimensions of a single cell. The building up of multicellular kites from the units is represented in the figures here reproduced from illustrations in Dr. Bell's article. Fig. 1 represents the unit cell, Fig. 2 a combination of four cells, Fig. 3 of sixty-four cells.

The kites fly with the points of the wings upward; the line of junction of the covered faces of the tetra-

hedron forms a kind of keel. No details as to the heights attainable are given. The most convenient place for the attachment of the flying end is said to be the extreme point of the bow. If the cord is attached to points successively further back on the keel, the flying end makes a greater and greater angle with the horizon, and the kite flies more nearly overhead; but it is not advisable to carry the point of attachment as far back as the middle of the keel. A good place for high flights is a point half way between the bow and the middle of the keel.

"Tetrahedral kites combine in a marked degree the qualities of strength, lightness, and steady flight; but further experiments are required before deciding that this form is the best for a kite or that winged cells without horizontal aëroplanes constitute the best arrangement of aëro-surfaces.

"The tetrahedral principle enables us to construct out of light materials solid frameworks of almost any desired form, and the resulting structures are admirably adapted for the support of aëro-surfaces of any desired kind, size, or shape."

The diagrams illustrating the article show various examples of the formation of complex kites from tetrahedral cells. One form suggested by Prof. Langley's aërodrome, but different in construction and appearance, is shown in Fig. 4, reproduced from an illustration in the article. That some of these complex kites are on a very large scale is evident from a case cited, in which an aërodrome kite, which was struck by a squall before it was let go, lifted two men off their feet, and subsequently broke its flying cord, a Manila rope of three-eighths inch diameter.

The simplicity of the construction of the cells, and the obvious possibilities of their combination, lend an additional fascination to a subject which is already full of interest.

BIBLE AND BABEL.

IN the number of the Johns Hopkins University *Circulars* for June (vol. xxii. No. 163), Prof. Paul Haupt has published an article entitled "Bible and Babel," referring to the somewhat heated controversy on Babel and the Bible which has raged recently in Germany, with which our readers are probably familiar. The line which he takes up is briefly that all the heterodox views which were expressed by Prof. F. Delitzsch in his famous lecture delivered in the august presence of the German Emperor had already been promulgated by himself, Prof. Haupt, at various periods during the last twenty-four years. Prof. Haupt claims to have made correct deductions in respect of the origins of the Biblical accounts of the Creation, the Deluge, &c., long before Prof. Delitzsch's lecture was delivered, but it must be clearly pointed out that, although such may be the case, he was not the first, even twenty-four years ago, to prove that the narratives, usually accredited to Moses are merely modified recensions which we owe to the prophets of the captivity in Babylon. Whatever credit is due either to Paul Haupt or Prof. Delitzsch in this matter, it must never be forgotten that all important statements made by them with regard to the Creation and Deluge tablets are derived from the works, writings, and oral remarks which were made by the late General Sir Henry Rawlinson, G.C.B., and the late Mr. George Smith, of the British Museum. Both Profs. Delitzsch and Haupt are skilled elaborators, but in our opinion they are not discoverers, and certainly neither of them can be placed side by side with such publishers and translators of text as the two famous Englishmen we have already mentioned. Still less can either be regarded as the author of the heterodox views and statements which so thoroughly shocked His Majesty the German Emperor.

NOTES.

IN connection with the tenth meeting of the Australasian Association for the Advancement of Science, to be held at Dunedin next January, particulars of which we gave in our issue for May 28 (p. 85), we learn from the *Otago Daily Times* that the colonial Government is rendering the Association material assistance. The New Zealand honorary secretary, Mr. G. M. Thomson, has received from Sir J. G. Ward, Colonial Secretary, a letter which states that the Government will assist the association in the following respects:—(1) A sum of 500*l.* will be placed on the Estimates of the present year towards the expenses of the January meeting; (2) the Government printer will be instructed to do all printing required by the association free of cost to the association; (3) railway passes will be issued to visiting members of the association; and (4) any assistance that it may be in the power of the permanent departments of the Government service to render to the association will be readily afforded on application being made.

AN entire skull (partially restored) of the remarkable Egyptian Eocene mammal *Arsinotherium zitteli* is now exhibited in the central hall of the Natural History Museum. This magnificent specimen was obtained by Dr. C. W. Andrews during his last trip to the Fayum district, and has been cleaned and restored in the museum. Behind the enormous nasal horns are placed a pair of quite small horns, recalling the rudimentary back-horns of the giraffe. The dentition, although including a full series of incisors and canines, recalls that of the Proboscidea. It is hoped that the skull of the Siberian rhinoceros (*Rhinoceros antiquitatis*) recently dug up in Salisbury Square, E.C., may ultimately find a home in the museum, since it is by far the finest example hitherto discovered in this country.

AT an extraordinary general meeting of the members of the Jenner Institute of Preventive Medicine, held on Friday last, the resolution recently passed on July 22 to alter the name of the institute to "The Lister Institute of Preventive Medicine" was unanimously confirmed.

THE fourteenth annual general meeting of the Institution of Mining Engineers will be held on Wednesday, September 2, in the University College, Nottingham.

THE Amsterdam Academy of Sciences has awarded its Buis-Ballot medal, given once in ten years, to Prof. Richard Assmann and Dr. Arthur Berson, of the Aëronautic Institute at Tegel, near Berlin.

REUTER states that a scientific expedition, to explore the northern parts of the Pacific Ocean, will leave Stockholm next April by railway for Port Arthur by way of Siberia. At Port Arthur the expedition will embark on a ship under the leadership of M. Kolthoff, who will be accompanied by five or six other Swedish naturalists.

SIR TREVOR LAWRENCE, president of the Royal Horticultural Society, has announced that Sir Thomas Hanbury, K.C.V.O., has purchased for presentation to the society the estate and garden of the late Mr. G. F. Wilson, F.R.S., at Wisley, near Woking. The total area of the estate is 60 acres.

AT the meeting of the Wilts County Council on August 4, a letter was read from Sir Edmund Antrobus, the owner of Stonehenge, to Lord Edmond Fitzmaurice, M.P. (chairman of the council), in which Sir E. Antrobus said he was willing to sell Stonehenge, and eight acres of land surrounding it, to the nation for the sum of 50,000*l.* The council decided to send the letter to the Chancellor of the Exchequer.

MISS DOROTHY BATE, whose investigation of the fossiliferous caves of Cyprus has recently created much interest among palæontologists, has also paid attention to the birds of that British dependency, and has written a paper on the subject which will appear in the next number of the *Ibis*. She has succeeded in making some good additions to the late Lord Lilford's "List of the Birds of Cyprus," which was published in 1889.

MR. R. C. L. PERKINS, who was employed for some years by the Sandwich Island Exploration Committee of the British Association to make zoological collections in the Hawaiian Archipelago, has received an appointment as economic entomologist in those islands, with the services of two assistants at his disposal. All the exertions that can be made will be required, as it is said that the crops in several of the islands are being completely ruined by introduced insects of various kinds and by fungoid diseases. No better selection could have been made for such a post, as Mr. Perkins is an expert on Hawaiian insects, and is still engaged in work upon them for the British Association committee.

THE manatee which has lately been added to the Zoological Society's living collection is an animal of much interest, as it does not belong to the ordinary species of the American coasts, but is a representative of the smaller form (*Manatus inunguis*) which is confined to the fresh waters of the Amazon. Here it was first discovered by the Austrian explorer Natterer, in the Rio Madeira, in 1830, and designated *inunguis* from the complete absence of nails on the hand, which are always present in *M. americanus*. A single living specimen of the same form was previously received by the Zoological Society in 1896, and its anatomy was described by Mr. Beddard in the *Proceedings* of the Zoological Society for 1897. The present manatee, which is a young animal about three feet long, has been placed in one of the tanks in the reptile house, and is fed principally upon lettuce. An excellent coloured figure of the marine manatee, based upon life-sketches made by the late Joseph Wolf, will be found in the mammal volume of Salvin and Godman's "Biologia Centrali-Americana."

ON the night of August 8 a destructive hurricane, which lasted five hours, swept over Martinique. The storm passed over Fort de France at 1 o'clock in the morning, taking a north-westerly direction. The barometer went down to 28.70 inches.

REPORTS of the following earthquake shocks on the Continent have appeared in the daily papers during the past few days:—*August* 9. Lisbon, 10.8 p.m. Three distinct shocks. Duration, three seconds, two seconds, and eight seconds respectively. Interval of two seconds between each shock.—*August* 11: Malta, 5.33 a.m. Duration, one minute. Naples, 5.35 a.m. Duration, two seconds. Syracuse, 5.38 a.m. Rumbling sounds heard. Canea, 6.9 a.m. Duration, thirty-two seconds. Direction, north to south. Walls of houses cracked. The shocks were felt in almost the whole of Eastern Sicily.

A LARGE party of delegates to the twenty-fourth annual meeting of French geographical and colonial societies, held at Rouen last week, is paying a visit to London, and on Monday was received by the council of the Royal Geographical Society, and entertained at luncheon. Twenty-four French geographical societies, nine kindred societies, and three foreign geographical societies were represented at the Rouen congress, and the members visiting England number eighty-two. At the luncheon, in responding to the toast of "The Geographical Societies of France," proposed by the chairman, Major Leonard Darwin, M. Zévort, rector of the University of Caen, and president of the congress, said his claim to speak in that assembly was that he was the rector of a university, French in its character, founded by an English king, that he represented a city which was visited every year by hundreds of English people, and he was, moreover, the nephew of Pasteur speaking to a son of Darwin. Wherever the French had worked and the English had followed there had been great progress in civilisation and in the peaceful development of the human race. That was the spirit in which the delegates came to this country, and it was in that spirit they were welcomed.

A REPORT by the director on the work in the engineering and physics departments of the National Physical Laboratory during the half year ended June 30 gives interesting particulars of the research work in progress. In the wind pressure research in the engineering laboratory, the case of flat surfaces exposed to a perpendicular current of air has been worked out, and a general relation established which is now being tested for the case of larger surfaces exposed to the natural wind. The case of parallel plates at varying distances apart has been treated, and experiments are also in progress on the pressure on inclined surfaces. Drawings have been prepared, and some preliminary tests made for the research into the constants of steam. In the physics department Dr. Harker has continued his comparison between the air thermometer, the platinum thermometer and the thermojunctions, and the work is now complete for temperatures between 0° C. and about 1050° C. The first part of the work for temperatures up to 500° C. was done with M. Chappuis, at Sèvres, and the results have been published. Dr. Harker has also constructed and subjected to stringent tests a set of platinum thermometers for the British Association. A small research on the specific heat of iron at high temperatures—700° C. to 1000° C.—is nearly complete, and promises to be of interest. Mr. F. E. Smith's research on the resistance of mercury and the construction of a standard mercury resistance is practically complete. The value of the specific resistance of mercury will probably prove to be very close to that determined by the director and Mr. Fitzpatrick in 1888. On the assumption that the absolute value of the wire standards in the laboratory is known, the length of the column of mercury, 1 sq. mm. in section, having a resistance of 10^9 C.G.S. units, is found to be almost exactly 106.29cm. The difference between Mr. Smith's results and those of the Reichsanstalt will not be more than some few parts in 100,000. An investigation of some importance into the changes in insulating strength of various dielectrics due to continued heating, by Mr. A. Campbell and Mr. Rayner, undertaken for the Engineering Standards Committee, promises to lead to results of value. In the metallurgical division the solidifying points and cooling curves of a series of pure iron carbon alloys have been determined, using platinum platinum-iridium and platinum platinum-rhodium thermojunctions. The range of carbon is from 0.15 to 3.55 per cent.; the range of temperature from 1502° C. to 1111° C. on the thermojunction scale. In addition to the above research work, nearly 600 tests have been made during the half year.

WE have received from Mr. E. Bohm two incandescent electric lamps which are specially designed to give good illumination vertically downwards. In both lamps the lower half of the bulb is made of fluted glass, which, acting as a row of lenses, serves to concentrate the light downwards;

one lamp has, in addition, opal glass for the upper half of the bulb, the filament being of the ordinary shape. The filament of the other lamp is fixed horizontally, and is zig-zag in shape; the upper half of the bulb in this case is of clear glass. The result of these designs is to give a distribution of light having the maximum candle-power in the vertical direction; in one of the lamps which we tested the vertical candle-power was 17·5, and the mean horizontal candle-power 10, thus practically reversing the values obtained with ordinary lamps. For situations in which good illumination directly below the vertical is specially required, these patterns of lamps should prove useful.

A VERY ingenious electrical type-setting machine is briefly described by M. Tavernier in a recent issue of the *Comptes rendus* of the Paris Academy of Sciences. The apparatus is similar in principle to the familiar linotype machines, but the operations of typing the copy and casting the type are separated; the operator works at an electrical typewriter, which produces a perforated tape, and at the same time an ordinary typed copy of the manuscript, which enables corrections to be made in the tape before the type is set up. The perforated tape is passed automatically through the type-setting machine, which is also operated electrically. The advantage of thus dividing the two operations is that the casting machine can be worked at a uniform maximum speed, and is independent of the skill of the typist. A further modification of the machine allows it to be used telegraphically; the perforated tape produced by the type-writer is passed through a transmitter, which sends signals over the line and reproduces in a receiving apparatus a duplicate of the tape, which can be used in the type-setting machine. The details of the various pieces of apparatus are not given, but there can be no doubt that the invention is likely to prove of great utility.

WE have received the forty-sixth volume of the "Year-book" of the Austrian Meteorological Service for 1901. The operations of the central office include the usual work of a normal observatory, the control of about 400 stations of various classes, and telegraphic weather forecasts. There are, in addition, a large number of stations dealing with thunderstorms and hail, but purely rainfall observations are now under the control of another department. An active part is taken in the international balloon ascents; we have frequently referred to some of the preliminary results obtained. Another feature of the Austrian service is the erection of a number of stations for "weather shooting" for the dissipation of thunder clouds and prevention of damage by hail, but the operations hitherto have not led to the hope of unqualified success. A separate appendix accompanies the "Year-book," which includes very valuable discussions on thunderstorm observations and on isotherms for Austria, both papers illustrated by charts. In the discussion of thunderstorms, some very interesting and instructive conclusions are drawn as to their connection with geographical features and the distribution of barometric pressure. It may be interesting to note here that out of 94 cases of damage to trees by lightning in 1901, 27 were pine or larch, 20 oak, 17 poplars, and 10 pear trees. The beech tree, which is generally supposed to be practically free from lightning strokes, was only struck once, but there were several other trees which similarly escaped damage.

AT the recent congress of the Royal Institute of Public Health, Prof. Moore, of Liverpool, read a paper upon a "Chemical Theory of the Transmission of Certain Infective Diseases." He pointed out that in many of the specific fevers no micro-organism has been isolated, and suggested that in these a chemical body of the nature of an enzyme may be the ætiological agent. To account for the reproduction of this chemical substance, which is necessary to explain the phenomenon of infection, Prof. Moore supposes that, by its action upon some of the cells, more of itself may be formed. He points out that there are analogies to this action in the case of certain "catalytic" reactions.

A SECOND report of the Special Chloroform Committee of the British Medical Association has just been issued. Mr. Vernon Harcourt, F.R.S., describes some experiments made to estimate the amount of chloroform which may be dissolved by the blood, and an apparatus for the limitation and regulation of chloroform vapour when administered as an anæsthetic. Dr. Dudley Buxton discusses the clinical use of certain inhalers (including Mr. Harcourt's form), and Mr. Walter Tyrrell reports upon the use of Mr. Harcourt's inhaler. Prof. Sherrington, F.R.S., and Mr. Sowton describe a number of experiments made to measure that dosage of chloroform under which the mammalian heart can, and cannot, work efficiently. They conclude that the heart muscle rapidly takes up chloroform offered to it in the blood-vessels of its vascular system.

CAPTAIN LAMB, I.M.S., has made a series of experiments upon the action of the venoms of the cobra and of Russell's viper (*Daboia Russellii*) upon the red-blood corpuscles and upon the blood plasma (*Scientific Memoirs of the Government of India*, New Series, No. 4). Both these venoms are shown to have a marked hæmolytic action, both *in vivo* and *in vitro*. Cobra venom never induces intra-vascular clotting; in fact, it rather diminishes blood coagulability, while Daboia venom causes extensive intra-vascular clotting. *In vitro* cobra venom prevents the clotting of citrated blood or plasma which ensues on the addition of a soluble calcium salt; Daboia venom, on the other hand, increases the tendency of citrated blood and plasma to coagulate. In conclusion, Captain Lamb considers that his experiments do not support Martin's hypotheses that all snake venoms contain at least two toxic proteids, one being a neurotropic, the other a hæmotropic, poison, and that the action on blood coagulability is due to a setting free of nucleo-proteids.

THE current issue of the *National Geographic Magazine* contains an article by Dr. H. W. Wiley, chief chemist of the Department of Agriculture, on "The United States; its Soils and their Products." Little is said about the special features exhibited by the soils of the country, the article being, in fact, a brief summary of the acreage, yield, and value of the main crops grown in the United States, useful to the student who has no opportunity of consulting the "Year-book" of the Department of Agriculture. The two facts that are most striking are the relatively low yield per acre and the enormous diversity of the agriculture; Dr. Wiley, indeed, asserts that "within the borders of the United States are grown every agricultural crop known to the world." The article is illustrated by several interesting photographs, calculated to impress the reader with the magnitude of the scale on which farming is practised in the United States.

A MOST interesting and remarkable instance of local adaptation to abnormal conditions on the part of a mollusc is recorded by Baron E. Nordenskjöld in No. 704 of the *Zool. Anzeiger*. It appears that in the "Chaco" districts of South America a species of fresh-water limpet (*Ancylus moricandi*) is found during the wet season in the pools which are then abundant in the country. During the dry season, however, these pools are completely desiccated, and

the whole country then becomes a practical desert, over which clouds of fine dust are swept by the wind. In order to exist during this season of drought, the Ancylus closes up almost the whole of the inferior aspect of its limpet-like shell by a growth of shelly matter continuous with the margin of the latter, leaving only a small circular mouth at one end. As is well known, many land molluscs, more especially *Helix pomatia,* are in the habit of sealing up the apertures of their shells during seasons of drought or heat, but in none of these is the substance with which the mouth is closed identical with that of the shell. In localities where there is no marked dry season, the Chaco Ancylus remains throughout the year in its normal condition.

In part i. of the general report and statistics relating to mines and quarries for 1902, issued by the Home Office, we note evidence of a general increase in production with regard to coal, fire-clay, ironstone, gypsum, rock-salt, &c. It is interesting to find that gold ore showed an increase from 16,374 tons in 1901 to 29,953 tons in 1902.

In a paper on the diffusion of granite into schists (*Geol. Mag.*, May), Mr. E. Greenly suggests that the granitoid matter that has been injected *lit par lit* was intruded while the surrounding rocks were at a high temperature, and this view would help to explain the occurrence of lenticles of granite in complete isolation from the parent mass.

A useful map of Peru, on the scale of 1 : 3,000,000, or an inch to a little more than forty miles, has been issued by Mr. Eduardo Higginson, Consul of Peru, Southampton. It shows the various ports and havens, railways completed and in progress, telegraphs, roads, forests, petroleum deposits, &c. On the back of the map are printed numerous particulars relating to the country, such as climate, agriculture, artesian wells, mineral wealth, manufactures, and various statistics. Of the industries, that of indiarubber is especially described.

To the *Proceedings* of the Geologists' Association for June (vol. xviii. part ii.), Dr. Catherine A. Raisin contributes an article on the formation of Chert, with especial reference to the bands and nodules in Jurassic strata. In some cases the silica may have originated from hot springs aided by the action of algæ; in other cases silica may have been directly derived from the sea water, but more often through the agency of siliceous organisms. Molecular changes that subsequently took place in the rocks have led to the dispersal and concentration of the silica in patches or layers. Mr. Jukes-Browne gives an account of the zones of the Upper Chalk in Suffolk.

In a paper on "The Marl-Slate and Yellow Sands of Northumberland and Durham," Prof. G. A. Lebour (*Trans.* Inst. Mining Eng.) remarks that these Permian strata rest on the stained edges of eroded Carboniferous rocks. Discussing the origin of the yellow sands which occur at the base of the Permian group, he is disposed to agree with R. Howse that they were wind-blown, and that consequently the overlying Marl-slate may rest somewhat irregularly upon them. Some of the inequalities observable between the divisions are, however, due to the fact that springs carry away portions of the sands, and this subterranean erosion leads to subsidence of the overlying Marl-slate or Magnesian Limestone. The Marl-slate is made up of thin limestones and shales, with marine shells and remains of land-plants, as well as amphibia, and numerous fishes the nearest existing analogues of which inhabit rivers and lakes. The organic remains thus indicate estuarine or lagunal conditions.

A German Bohemian Archæological Expedition to Asia Minor, conducted by Drs. J. Jüthner, K. Patsch and H. Swoboda, and Architect F. Knoll, left Konia (Iconium) on April 4 on a roundabout journey to Isaura, to link on with the work of the Vienna Academy. They visited various towns and villages between Konia and the Lake of Bey Schehir, and investigated the interesting Hittite temple at Fassiler previously discovered by the American explorer Sterrett. In Kyzyldschakiöj they made their most valuable epigraphical discovery of two fragments of a limestone stele, which is important since it bears on the history of the second century B.C., and illustrates certain aspects of Greek public law. An illustration is given of the ruined gate of the acropolis of ancient Isaura which confirms the statement that very little now remains. More than three hundred inscriptions were found, and numerous photographs were taken of monuments and landscapes; the map accompanying the report in *Deutsche Arbeit* (vol. ii. Heft 10, p. 784) was drawn by Prof. Jüthner.

Prof. James Walker's "Elementary Inorganic Chemistry," published by Messrs. Geo. Bell and Sons, and reviewed in our issue for June 19, 1902, has been translated into German by Margarete Egebrecht and Emil Bose. The translation has been published by Messrs. F. Vieweg and Son, of Brunswick.

A second edition of the "Guide to the Search Department of the Patent Office Library, with Appendices," has been published at the Patent Office, Chancery Lane. The first appendix is a descriptive list of unofficial class-lists, and digests of English and foreign patent specifications, and the second contains a select dictionary of words and phrases associated with inventions introduced under letters patent.

We have received copies of the *Compte rendu* of the proceedings of the 1901 meeting of the Société Helvétique des Sciences Naturelles, held at Zofingen, and that of the 1902 meeting held at Geneva. The two volumes of *Verhandlungen* and *Actes,* containing the papers presented and addresses delivered in connection with the same meetings, have also reached us.

Subjects of scientific interest take a prominent place in the current issue of the *Century Magazine.* Mr. Frank W. Stokes, who accompanied the Swedish South Polar Expedition under the leadership of Dr. Otto Nordenskjöld, contributes an article entitled "An Artist in the Antarctic," which is accompanied by three beautifully coloured plates by the author, and these give a vivid impression of the region described. M. J. Deniker writes of Lhasa, under the title "New Light on Lhasa, the Forbidden City." Miss A. K. Fallows explains, in a well illustrated paper, the means adopted to secure for New York a supply of pure milk.

The first part of vol. ii. of "The Fauna and Geography of the Maldive and Laccadive Archipelagoes: being an Account of the Work carried on and of the Collections made by an Expedition during the Years 1899 and 1900," which is being edited by Mr. J. Stanley Gardiner, has been issued by the Cambridge University Press. The first part of vol. i. of this work was reviewed in our issue of April 3, 1902, and the remaining volumes will be dealt with after the publication of the concluding part. The present fasciculus contains reports by Prof. S. J. Hickson, F.R.S., and Miss E. M. Pratt on the Alcyonaria of the Maldives, by Sir Charles

Eliot on Nudibranchiata, by Mr. L. A. Borradaile on the sponge-crabs, and by Sir John Murray, F.R.S., and the editor on lagoon deposits.

THE *Proceedings* of the Washington Academy of Sciences for July 18 is made up of a full account of a meeting held in Columbia University, under the auspices of the Washington Academy, to commemorate the distinguished services to knowledge of the late Major John Wesley Powell, together with a list of the 251 papers and articles written by him during the years 1867 to 1903. Major Powell's work as director of the Bureau of American Ethnology is well known to anthropologists, and his services to science as an explorer, geologist and organiser are of the same high value. As an observer in many fields of natural science, and as one who exerted great influence on scientific progress, Major Powell's memory will long be held in honour.

MESSRS. CHARLES GRIFFIN AND CO., LTD., have now published a tenth edition of Mr. Bennett H. Brough's "Treatise of Mine-Surveying." The book was first published in 1888, and was reviewed at length in our issue of August 2 of that year. The prediction made on that occasion—"as soon as the book becomes known, no English-speaking mine-agent or mining student will consider his technical library complete without it"—has been fully justified, as the issue of a tenth and revised edition shows. Descriptions of appliances invented since the ninth edition appeared at the beginning of last year have now been inserted in the book, and among these additions will be found accounts of Sir Howard Grubb's new sight for mining dials, of Gothan's instrument for surveying bore-holes, and of the Dunbar-Scott mine tacheometer. Besides these improvements, references to important papers lately published and recent examinations questions have been added.

THE current number of the *Popular Scientific Monthly*, in addition to other articles of general scientific interest, reprints the Romanes lecture delivered last June by Sir Oliver Lodge, F.R.S., and publishes the third of a series of papers on Hertzian wave wireless telegraphy by Prof. J. A. Fleming, F.R.S. Other papers are on the bird rookeries on the island of Laysan, and bacteria in modern economic agriculture. From the columns headed the progress of science we learn there are now somewhat more than 100,000 students in the colleges, universities, and technical schools of the United States, and somewhat more than 50,000 in the professional schools of theology, law and medicine. In 1901, 16,513 students graduated from colleges and technical schools, and of these 5050 were women. The number of pupils in secondary schools was in 1901 upwards of 600,000, as compared with less than 100,000 in 1878.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. — Townshend; two Malayan Bears (*Ursus malayanus*) from Malacca, presented by the Right Hon. Earl of Crawford; two Norwegian Lemmings (*Myodes lemmus*) from Norway, presented by Major-General C. S. Sturt; two Dwarf Chameleons (*Chamaeleon pumilus*) from South Africa, presented by Mrs. Mainwaring; four Tuberculated Iguanas (*Iguana tuberculata*) from Venezuela, three Elephantine Tortoises (*Testudo elephantina*) from the Aldabra Islands, two Radiated Tortoises (*Testudo radiata*) from Madagascar, deposited; a Japanese Deer (*Cervus sika*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

BORRELLY'S COMET (1903 *c*).—The following elements and ephemeris for Borrelly's comet have been computed by Dr. Aitken, of the Lick Observatory, from observations made on June 22 and 30, and July 10 (Lick Observatory *Bulletin*, No. 47):—

Elements.

T = 1903 August 27·6056 G.M.T.

$$\left.\begin{array}{rl} \omega = & 127^\circ\ 19'\ 25''\cdot5 \\ \Omega = & 293\ \ 32\ \ 55\cdot0 \\ i = & 84\ \ 59\ \ 45\cdot3 \end{array}\right\} 1903\cdot0$$

$$\log q = 9\cdot518126$$

Ephemeris 12h. G.M.T.

1903		True α (h. m. s.)		True δ (° ′)		log Δ		Brightness
Aug. 13·5	...	10 54 23	...	+39 24·1	...	—	...	—
„ 15·5	...	10 48 12	...	+37 42·9	...	9·947	...	6·7
„ 17·5	...	10 42 2	...	+35 58·0	...	—	...	—
„ 19·5	...	10 35 58	...	+34 7·2	...	9·996	...	7·4
„ 21·5	...	10 29 54	..	+32 7·0	...	—	...	—
„ 23·5	...	10 24 3	...	+29 54·8	...	0·038	...	8·2
„ 25·5	...	10 18 30	...	+27 27·0	...	—	...	—
„ 27·5	...	10 13 31	...	+24 47·3	...	0·074	...	7·9
„ 29·5	...	10 9 20	...	+21 54·6	...	—	...	—
„ 31·5	...	10 5 59	...	+18 53·8	...	0·100	...	6·2

PROJECTION ON MARS.—In the first *Bulletin* issued by the Lowell Observatory, Flagstaff, Arizona, Mr. Percival Lowell describes the observations of a projection which was discovered on the terminator of Mars by Mr. Slipher at 15h. 34m. (G.M.T.) on May 25. Messrs. Lowell and Slipher afterwards alternately observed the projection, which lasted for about thirty-one minutes; the position angle varied from 204°·0 to 199°·8, and the projection was variously estimated as being removed from the terminator by a perpendicular distance of 0·067–0·075 of the radius of the disc; its length was 1″·58, and it disappeared at 16h. 8m.

The projection was "suspected" again at 15h. 58m. on May 27, and, if really seen, had moved 7° in latitude and 8° in longitude during the twenty-four hours' interval. The observations lead to the conclusion that the projection was probably a cloud of *dust* about 300 miles long, travelling at about 16 miles an hour in a north-easterly direction, and dissipating as it went.

THE SATELLITE OF NEPTUNE.—Using the Crossley reflector, Prof. Perrine has obtained a series of photographs of Neptune's satellite which cover one complete revolution, January 4–January 16, 1902.

The measurements of forty-five plates show that a correction of +0°·55, with a probable error of ±0°·09 in position angle, and of −0″·006, with a probable error of ±0″·020 in distance, must be applied to Hall's elements as published in No. 441 of the *Astronomical Journal*.

The observations are recorded in *Bulletin* No. 39 of the Lick Observatory, which also contains a series of determinations of the position of the planet itself, at certain times, as determined from the same photographs.

THE ESTIMATION OF STELLAR TEMPERATURES.—The question of the relative temperatures of the different types of stars is one of the most important in astrophysics, and has lately been the subject of much discussion in consequence of the discovery that spark lines appear in the arc spectrum under certain special conditions. In *Astr. Nach.* (No. 3882), after reviewing the recent contributions to the discussion, Prof. Kayser suggests a method of estimating the temperatures of stars which is based on an idea put forward in 1876 by Sir George Stokes in a note appended to a paper by Sir Norman Lockyer (Roy. Soc. *Proc.*, vol. xxiv. pp. 352–4). In the case of an incandescent solid body the proportion of the more refrangible radiations increases with the temperature, and Stokes suggested that a line spectrum might behave in the same manner, so that at different temperatures different lines would be most persistent. Prof. Kayser thinks that, while this may not hold for the whole spectrum, it may be true for the lines of a definite series, such as those of hydrogen, or one of the series of lines of helium. On this supposition he has recently undertaken a preliminary investigation for the

detection of such variations in the spectra of hydrogen, helium, and lithium, and has obtained indications that the energy of the shorter waves is relatively increased with increase of temperature, assuming that the temperature in Geissler tubes rises with increased potential and current strength. It is considered probable that further laboratory experiments combined with photometric or photographic estimates of the intensities of the stellar lines may result in a fairly accurate knowledge of the temperatures of some of the stars; great progress will have been made if the temperatures can only be ascertained within one or two thousand degrees.

OBSERVATIONS OF THE MINIMA OF MIRA.—In No. 3888 of the *Astronomische Nachrichten*, Prof. A. A. Nijland records his observations of the last minimum of Mira, which took place during December. Plotting his observations on a curve, he found that the actual minimum occurred on December 17, 353 days after the minimum of December 29, 1901, the magnitude on that date being 8·70 on the Harvard photometer scale.

The following table shows the differences between the dates of minima as predicted by Guthnick (*Astronomische Nachrichten*, No. 3745) and those actually observed:—

Observed		Guthnick		O–G
1901 Feb. 16	...	1901 March 6	..	−18 days
„ Dec. 29	...	1902 Jan. 31	...	−33 „
1902 „ 17	...	„ Dec. 28	...	−11 „

THE SIZE OF STELLAR SYSTEMS.—In an editorial article in the *Observatory* for August, a table is given which compares the dimensions of various stellar systems with those obtaining in the solar system. As the writer states, these are not generally known or not remembered, therefore he has tabulated a few of the more interesting and approximately known data, which must, however, only be taken as approximations owing to the uncertainty of the original data from which they are computed.

Object	Separation of components		Motion across the line of sight, in millions of miles per annum
—	In astronomical units	In millions of miles	—
Earth	1·0	93	—
Saturn	9·5	883	—
Procyon	17·3	1,608	372
Uranus	19·2	1,782	—
Sirius	21·1	1,962	316
α Centauri	23·3	2,167	465
Castor	27·5	2,557	140
Neptune	30·1	2,792	—
o_2 Eridani (B and C)	34·5	3,207	2,000
η Cassiopeiæ	44·7	3,947	580
θ Ursæ Maj.	63·0	5,860	1,300
61 Cygni	68·0	6,324	1,116
Polaris	250	23,250	133
Aldebaran	282	26,226	170
θ_2 Eridani (A and B)	455	42,315	2,000

RECENTLY DETERMINED STELLAR PARALLAXES.—No. 10 of the *Publications* of the Groningen Astronomical Laboratory contains the details of the observations and reductions of parallax for the stars and clusters "*h* and χ Persei," "745 Groombridge," and "61 Cygni and the surrounding stars." The photographs from which the parallactic values were determined were obtained by Prof. A. Donner, and have been reduced by Prof. J. C. Kapteyn and Dr. W. de Sitter.

In the summary given for the cluster *h* and χ Persei, 178 stars are included, and it will be possible, when it has been decided, from observations of their proper motions, whether or not the individual stars actually belong to the cluster, to determine the parallax of this cluster with extreme accuracy.

The parallax of 745 Groombridge relative to stars of the mean magnitude 9·0 was found to be $+0''.083 \pm 0''.024$, and on consideration of the star's magnitude (8·2) and its annual proper motion (0″·64), +0″·068 was accepted as the most probable value of this parallax.

The final value of the parallax of 61 Cygni relative to the four comparison stars (mean magnitude =7·4) is given as $+0''.326 \pm 0''.035$; the plates from which this result was obtained do not confirm the existence of any real difference of parallax between the two components.

No. 11 of the same *Publications* contains a discussion on "The Luminosity of the Fixed Stars" by Prof. J. C. Kapteyn.

EXPERIMENTS IN RADIO-ACTIVITY, AND THE PRODUCTION OF HELIUM FROM RADIUM.[1]

(1) *Experiments on the Radio-activity of the Inert Gases of the Atmosphere.*

OF recent years many investigations have been made by Elster and Geitel, Wilson, Strutt, Rutherford, Cooke, Allen, and others on the spontaneous ionisation of the gases of the atmosphere and on the excited radio-activity obtainable from it. It became of interest to ascertain whether the inert monatomic gases of the atmosphere bear any share in these phenomena. For this purpose a small electroscope contained in a glass tube of about 20 c.c. capacity, covered in the interior with tin-foil, was employed. After charging, the apparatus if exhausted retained its charge for thirty-six hours without diminution. Admission of air caused a slow discharge. In similar experiments with helium, neon, argon, krypton, and xenon, the last mixed with oxygen, the rate of discharge was proportional to the density and pressure of the gas. This shows that the gases have no special radio-activity of their own, and accords with the explanation already advanced by these investigators that the discharging power of the air is caused by extraneous radio-activity.

Experiments were also made with the dregs left after liquefied air had nearly entirely evaporated, and again with the same result; no increase in discharging power is produced by concentration of a possible radio-active constituent of the atmosphere.

(2) *Experiments on the Nature of the Radio-active Emanation from Radium.*

The word emanation originally used by Boyle ("substantial emanations from the celestial bodies") was resuscitated by Rutherford to designate definite substances of a gaseous nature continuously produced from other substances. The term was also used by Russell ("emanation from hydrogen peroxide") in much the same sense. If the adjective "radio-active" be added, the phenomenon of Rutherford is distinguished from the phenomena observed by Russell. In this section we are dealing with the emanation, or radio-active gas obtained from radium. Rutherford and Soddy investigated the chemical nature of the thorium emanation (*Phil. Mag.*, 1902, p. 580) and of the radium emanation (*ibid.*, 1903, p. 457), and came to the conclusion that these emanations are inert gases which withstand the action of reagents in a manner hitherto unobserved except with the members of the argon family. This conclusion was arrived at because the emanations from thorium and radium could be passed without alteration over platinum and palladium black, chromate of lead, zinc dust, and magnesium powder, all at a red-heat.

We have since found that the radium emanation withstands prolonged sparking with oxygen over alkali, and also, during several hours, the action of a heated mixture of magnesium powder and lime. The discharging power was maintained unaltered after this treatment, and inasmuch as a considerable amount of radium was employed it was possible to use the self-luminosity of the gas as an optical demonstration of its persistence.

In an experiment in which the emanation mixed with oxygen had been sparked for several hours over alkali, a minute fraction of the total mixture was found to discharge an electroscope almost instantly. From the main quantity

[1] By Sir William Ramsay, K.C.B., F.R.S., and Mr. Frederick Soddy. Received at the Royal Society July 28.

of the gas the oxygen was withdrawn by ignited phosphorus, and no visible residue was left. When, however, another gas was introduced, so as to come into contact with the top of the tube, and then withdrawn, the emanation was found to be present in it in unaltered amount. It appears, therefore, that phosphorus burning in oxygen and sparking with oxygen have no effect upon the gas so far as can be detected by its radio-active properties.

The experiments with magnesium-lime were more strictly quantitative. The method of testing the gas before and after treatment with the reagent was to take 1/2000th part of the whole mixed with air, and after introducing it into the reservoir of an electroscope to measure the rate of discharge. The magnesium-lime tube glowed brightly when the mixture of emanation and air was admitted, and it was maintained at a red-heat for three hours. The gas was then washed out with a little hydrogen, diluted with air and tested as before. It was found that the discharging power of the gas had been quite unaltered by this treatment.

The emanation can be dealt with as a gas; it can be extracted by aid of a Töpler pump; it can be condensed in a U-tube surrounded by liquid air; and when condensed it can be "washed" with another gas which can be pumped off completely, and which then possesses no luminosity and practically no discharging power. The passage of the emanation from place to place through glass tubes can be followed by the eye in a darkened room. On opening a stopcock between a tube containing the emanation and the pump, the slow flow through the capillary tube can be noticed; the rapid passage along the wider tubes; the delay caused by the plug of phosphorus pentoxide, and the sudden diffusion into the reservoir of the pump. When compressed, the luminosity increased, and when the small bubble was expelled through the capillary it was exceedingly luminous. The peculiarities of the excited activity left behind on the glass by the emanation could also be well observed. When the emanation had been left a short time in contact with the glass, the excited activity lasts only for a short time; but after the emanation has been stored a long time the excited activity decays more slowly.

The emanation causes chemical change in a similar manner to the salts of radium themselves. The emanation pumped off from 50 milligrams of radium bromide after dissolving in water, when stored with oxygen in a small glass tube over mercury turns the glass distinctly violet in a single night; if moist the mercury becomes covered with a film of the red oxide, but if dry it appears to remain unattacked. A mixture of the emanation with oxygen produces carbon dioxide when passed through a lubricated stopcock.

(3) *Occurrence of Helium in the Gases Evolved from Radium Bromide.*

The gas evolved from 20 milligrams of pure radium bromide (which we are informed had been prepared three months) by its solution in water and which consisted mainly of hydrogen and oxygen (*cf.* Giesel, *Ber.*, 1903, 347) was tested for helium, the hydrogen and oxygen being removed by contact with a red-hot spiral of copper wire, partially oxidised, and the resulting water vapour by a tube of phosphorus pentoxide. The gas issued into a small vacuum-tube which showed the spectrum of carbon dioxide. The vacuum tube was in train with a small U-tube, and the latter was then cooled with liquid air. This much reduced the brilliancy of the CO_2 spectrum, and the D_3 line of helium appeared. The coincidence was confirmed by throwing the spectrum of helium into the spectroscope through the comparison prism, and shown to be at least within 0·5 of an Ångström unit.

The experiment was carefully repeated in apparatus constructed of previously unused glass with 30 milligrams of radium bromide, probably four or five months old, kindly lent us by Prof. Rutherford. The gases evolved were passed through a cooled U-tube on their way to the vacuum-tube, which completely prevented the passage of carbon dioxide and the emanation. The spectrum of helium was obtained and practically all the lines were seen, including those at 6677, 5876, 5016, 4932, 4713, and 4472. There were also present three lines of approximate wave-lengths, 6180, 5695, 5455, that have not yet been identified.

On two subsequent occasions the gases evolved from both solutions of radium bromide were mixed, after four days' accumulation which amounted to about 2·5 c.c. in each case, and were examined in a similar way. The D_3 line of helium could not be detected. It may be well to state the composition found for the gases continuously generated by a solution of radium, for it seemed likely that the large excess of hydrogen over the composition required to form water, shown in the analysis given by Bodländer (*Ber., loc. cit.*) might be due to the greater solubility of the oxygen. In our analyses the gases were extracted with the pump, and the first gave 28·6, the second 29·2 per cent. of oxygen. The slight excess of hydrogen is doubtless due to the action of the oxygen on the grease of the stopcocks, which has been already mentioned. The rate of production of these gases is about 0·5 c.c. per day for 50 milligrams of radium bromide, which is more than twice as great as that found by Bodländer.

(4) *Production of Helium by the Radium Emanation.*

The maximum amount of the emanation obtained from 50 milligrams of radium bromide was conveyed by means of oxygen into a U-tube cooled in liquid air, and the latter was then extracted by the pump. It was then washed out with a little fresh oxygen, which was again pumped off. The vacuum tube sealed on to the U-tube, after removing the liquid air, showed no trace of helium. The spectrum was apparently a new one, probably that of the emanation, bur this has not yet been completely examined, and we hope to publish further details shortly. After standing from July 17 to 21, the helium spectrum appeared, and the characteristic lines were observed identical in position with those of a helium tube thrown into the field of vision at the same time. On July 22 the yellow, the green, the two blues and the violet were seen, and in addition the three new lines also present in the helium obtained from radium. A confirmatory experiment gave identical results.

We wish to express our indebtedness to the research fund of the Chemical Society for a part of the radium used in this investigation.

ON THE INTENSELY PENETRATING RAYS OF RADIUM.[1]

RADIUM is known to emit three types of radiation. These are:—

(1) The α rays, very easily absorbed by solids, and carrying a positive electric charge.

(2) The β rays, more penetrating than these, and negatively charged.

(3) The γ rays, intensely penetrating, and not conveying an electric charge at all.

In a paper published in the *Phil. Trans.* for 1901, I investigated the relative ionisations of gases by the α and β rays. The present communication may be regarded as a sequel to that one, and deals with the γ rays.

The radium employed was of activity 1000 (uranium = 1), and was contained in a glass cell, over which was cemented a piece of thin aluminium. The cell was placed in a cavity in a block of lead, and over it was placed a disc of lead 1 cm. in thickness. This it was considered would suffice to suppress all but the γ rays, which are much the most penetrating.

In measuring the electrical leakage, the electroscope method was employed. The apparatus was that described in a paper published in the *Philosophical Magazine* for June, p. 681.

The radium, covered by the thick lead, was placed under the apparatus, and the rate of leak determined when the different gases filled the testing vessel.

The conditions were, of course, arranged so as to use a saturating E.M.F. The γ rays are so penetrating that there can be no question of their being appreciably absorbed in a moderate thickness of gas.

For the methods of preparation of the gases I must refer to the former paper (*Phil. Trans.*, A., vol. cxcvi., 1901, p. 508).

[1] By Hon. R. J. Strutt, Fellow of Trinity College, Cambridge. Communicated to the Royal Society by Lord Rayleigh, F.R.S. Received August 5.

The results were as follows; the rates of leak are given in scale divisions per hour, and are corrected to 30 inches pressure:—

Gas	Rate of Leak	Mean
Hydrogen	10·4, 10·5, 10·4, 11·2, 10·4, 11·2, 9·86, 10·1, 10·2 ...	10·5
Air	65·2, 66·6, 66·6, 60·0, 57·0, 61·5, 60·2, 63·0, 58·2, 58·3, 56·6, 56·2	62·1
Oxygen	75·0, 74·2, 71·0, 74·1	73·6
Carbon dioxide	96·0, 95·4, 94·5, 95·1, 94·1, 94·7	95·0
Cyanogen	107, 104, 106, 106	106·0
Sulphur dioxide... ...	132, 126, 134, 135	132·0
Chloroform	297, 298, 290, 327	303·0
Methyl iodide	298, 292, 310, 291	298·0
Carbon tetrachloride ..	363, 351, 344, 349	352·0

The following table gives the relative ionisations, referred to air as unity. The values of the same constants for the α and β rays formerly found are included, and also measurements of relative ionisation under Röntgen rays. These latter form part of an investigation not hitherto published.

Relative Ionisations.

Gas	Relative density	Relative Ionisation			
		α rays	β rays	γ rays	Röntgen rays
Hydrogen	0·0693	0·226	0·157	0·169	0·114
Air	1·00	1·00	1·00	1·00	1·00
Oxygen	1·11	1·16	1·21	1·17	1·39
Carbon dioxide	1·53	1·54	1·57	1·53	1·60
Cyanogen	1·86	1·94	1·86	1·71	1·05
Sulphur dioxide	2·19	2·04	2·31	2·13	7·97
Chloroform	4·32	4·44	4·89	4·88	31·9
Methyl iodide	5·05	3·51	5·18	4·80	72·0
Carbon tetrachloride ...	5·31	5·34	5·83	5·67	45·3

The determinations for the γ rays are less accurate than the former ones for the α and β rays, on account of the very much smaller rates of leak which have to be measured. I think, if this be taken into account, there is no reason to doubt that, within the limits of experimental error, the γ rays give the same values as the β rays. These values are nearly proportional to the density of the gas, except in the case of hydrogen. The law which holds in the case of Röntgen rays is totally different.

This conclusion throws some light on the nature of the β rays. The view seems to be gaining ground that these are Röntgen rays, produced by the impact of the β rays on the radium itself.[1] This theory seems to have much to recommend it. The β rays should, by analogy with the kathode rays in a vacuum tube, produce Röntgen rays when they strike a solid obstacle, and these Röntgen rays should be much more penetrating than the β rays themselves. The γ rays seem at first sight to be just what should be expected. But the present paper shows that in one respect, at all events, the γ rays behave quite differently from Röntgen rays, while, on the other hand, they resemble the α and β rays. There seems to be a possibility that they too are of a corpuscular nature, though uncharged with electricity. This would account for the absence of magnetic deflection.

I do not think that the absence of conspicuous Röntgen radiation is very hard to understand, if we consider that the current emitted in kathode rays by a square inch of intensely active radium is only 10^{-11} amperes; the current through a focus tube is of the order 10^{-3} amperes, and probably a great part of this is carried by the kathode rays.

[1] See, for instance, Madame Curie, "Thèses presentées à la Faculté des Sciences," 1903, p. 83.

THE COLORATION OF THE QUAGGAS.

IT is well known that, in different districts of their range, the zebras of the type commonly known as Burchell's, but which, for reasons elsewhere given, I propose to call "quaggas," present distinct and easily determinable colour variations, sufficiently constant in character to be worthy of nominal recognition. Grant's quagga occurs in North-East Africa, Crawshay's quagga in Nyasaland, Selous's quagga in Rhodesia, and Chapman's quagga in Angola. Still further south came Burchell's quagga, and south of this again the two or more extinct types which, as Mr. Lydekker has shown, pass currently as the quagga proper.

The first and last of this category are the extremes in pattern variation. Grant's quagga may claim to rank as one of the most completely striped of existing horses. Apart from the ears, which are sometimes nearly white, and the muzzle and fetlocks, which are usually black, he is a mass of stripes from head to tail, from hoof to spine; and in sharpness of contrast between the blackness of the stripes and the whiteness of the interspaces, he rivals the Abyssinian race of Grévy's zebra and the Angolan race of the mountain species, while surpassing both in the inferior extension of the stripes to the middle line of the belly. Place him alongside Gray's quagga, with his pale stripeless limbs, underside and hind-quarters, his brown and confusedly banded body and fawn-lined neck and head, and you will hardly believe them to be the same species. Yet there is no avoidance of the conclusion, since all intermediates have been seen either as living specimens or mounted skins. And one of the chief interests centred in the existence of these intermediates lies in the progressiveness of the change this species undergoes as it passes from north to south over its geographical area. Even in British and German East Africa the pale interspaces on Grant's quagga begin to be washed with brown, and to be filled in with narrower intervening stripes. It will be difficult, perhaps impossible, to distinguish such forms from the quagga of the Mashonaland plateau. The latter, indeed, may be taken as illustrative of the first step in the change above alluded to leading from Grant's to Gray's quagga. From it may be traced a series of gradations represented by the local races named after Chapman, Wahlberg, and Burchell, in which the stripes gradually disappear and thin out upwards from the fetlocks to the shoulders and haunches, while those on the body lose their connection with the mid-ventral band, and, becoming shorter, leave the belly unstriped. Concomitantly the intervening "shadow" stripes increase in number and definition as they extend forwards towards the neck, the normal stripes themselves turn brown, and the ochre-stained ground colour deepens in hue. In the typical form of Burchell's quagga the "shadow" stripes reach the head, and the last of the complete stripes is the one that extends backwards from the stifle to the root of the tail, the hind-quarters and legs being practically, and the belly actually, stripeless. It is but a step from this to the extinct Gray's quagga, in which the stripes of the body were fused together and blended to a great extent with the brown of the intervening areas, those on the neck being exceedingly broad and broken up by paler tracts of hair.

The tendency of these modifications is to convert a striped and conspicuously parti-coloured animal into one which, even at a short distance, must have appeared to be an almost uniform brown, paling into cream on the underside, limbs and back of the haunches. What is the meaning of this change? Inferentially we may conclude it was protective in the sense of subserving concealment.

The testimony of observers in the field has established the truth that the coloration of the coat renders a zebra invisible under three conditions, namely, at a distance on the open plain in midday, at close quarters in the dusk and on moonlit nights, and in the cover afforded by thickets. The procryptic result is achieved by the cooperation of several factors. The white stripes blend with the shafts of light sifted through the foliage and branches and reflected by the leaves of the trees, and in an uncertain light or at long range they mutually counteract each other and fuse to a uniform grey. It is probable, too, that the alternate arrangement of the black and white bars contributes something to the effect produced, by imparting a blurred appear-

ance to the body and destroying the evenness of its surface owing to the difference in light-reflecting power between hairs of these hues to which domestic horses bear witness. Moreover, the extension of the stripes to the very edge of the body and legs breaks up the continuity of the outline, and this, I believe, is the reason for the alteration in their direction on the hind-quarters and limbs, so that, except on the forehead, the whole animal is barred transversely with reference to its spinal and appendicular axes.

We have also the positive assurance of observers that the asses of the deserts of North-East Africa are perfectly adapted to their surroundings in colour, and no one can doubt that the assimilation is equally perfect in the case of the kiang and Prjevalsky's ponies[1] of Central Asia. In the matter of colouring the kiang forcibly recalls the typical quagga, despite a decided difference in the deepness of the brown pervading the upper parts in the two species. Notwithstanding this difference, there can, I think, be no question that the explanation to be given of the significance of the colours of the kiang applies with equal truth to the quagga. This explanation is the hypothesis of the counteraction of light and shade put forward by the American artist, Thayer.

It would be hard to find a better and simpler instance of this style of coloration than the kiang. The upper parts on which the light falls are of a rich ruddy hue, darker than ordinary sand, while the muzzle, the lower side of the head, the throat and the belly are creamy white. Surely no one with a knowledge of the truth enunciated by Thayer will

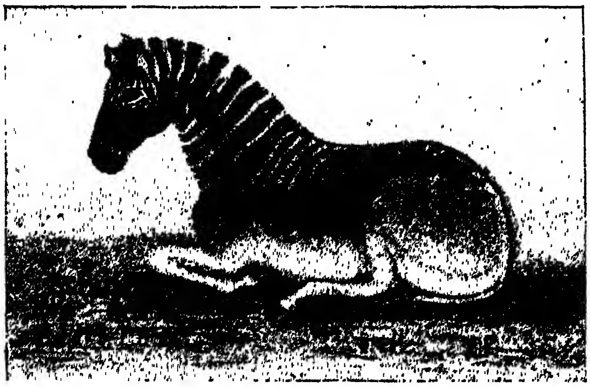


FIG. 1.—Gray's Quagga lying, to show the unbroken continuity of the white on the underside.

dispute that the arrangement and nature of the colours in the kiang must render it practically invisible when standing in the desert at a distance. But this is not all. Why are the legs, or at least the greater part of them, and the backs of the thighs up to the root of the tail also white? This is doubtless the reason. When the kiang rests on the ground in the attitude characteristic of ungulates, with the hind-quarters depressed, the fore-legs folded and the hind-legs tucked in close to the body, the white on the back of the thighs is brought into line with that of the belly, and a continuous expanse of white, obliterating the shadow, extends all along the underside from the knee to the root of the tail. So, too, with the quagga. This, then, is the meaning of the change in pattern presented by the African species as it passed southwards into Cape Colony. In correlation with the adoption of a life in the open, a new method of concealment by means of shadow counteraction was required, and was gradually perfected by the toning down of the stripes on the upper side and the suppression of those on the hind-quarters, belly and legs.

The same alignment of the white on the rump and belly may be seen in many antelopes, like gazelles, and the co-operation of the legs in increasing the underlying area of white is especially well shown in the bonte-bok.

Now the rump-patches, be it noted, only subserve the purpose here suggested when the animals that possess them are lying on the ground. This, however, is the time, as they drowsily rest or chew the cud, when concealment is of the greatest importance to ungulates, which are, for the most part, clumsy risers, and slow at getting under way. When standing and on the alert, their need for concealment, though seldom absent, is certainly less, and when they are on the run all idea of it is thrown to the winds. It is then that the rump-patches act, as Mr. Wallace suggested, as danger signals and "follow-the-leader" marks, showing the young and inexperienced which way to go, and helping the members of a herd to foregather in the dark when dispersed by the panic of a night attack.

The pattern of a zebra, in its entirety, is also believed by Mr. Wallace to have a double significance analogous to the above. It is known to be procryptic; but he holds that it acts as a badge of recognition, enabling the zebras to distinguish their own kind amongst the herds of other beasts that may be feeding in the same place. It may be so; for although seemingly contradictory, the two explanations are not mutually exclusive. The procryptic effect of the pattern is largely a matter of distance and light. At close quarters in broad daylight a zebra is conspicuous unless under cover, and the colouring is strikingly unlike that of other animals. On the other hand, it must be remembered, as I have elsewhere pointed out (NATURE, October 11, 1900), that the species, like wildebeests, zebras, spring-buck, or even ostriches, which formerly at all events fed together upon the veldt,[1] are so dissimilar in size and shape that the need for a distinctive type of coloration to prevent the postulated likelihood of specific confusion can hardly have been a sufficiently important factor in survival to have guided the evolution of the colour for the purpose supposed. And since we have evidence of the best kind that the pattern of zebras and quaggas is procryptic, it seems unnecessary to look further for its explanation.

R. I. POCOCK.

1 A suspicious inconstancy about their coloration inclines me to the opinion that these ponies are the descendants of "runaways."

1 These odd friendships are a great puzzle; but perhaps the following suggestions may throw some light upon their occurrence and use. It is unlikely in the extreme that all the species concerned have their sense organs developed to an equal pitch of excellence. In one the sense of smell, in another the sense of sight, in a third the sense of hearing will be pre-eminently keen. Hence the sensory imperfections of one species will be made good by the proficiencies of the others; and each will be benefited by the association. Ostriches, for instance, in virtue of their stature and long sight, will see an enemy in open country at a much greater distance than will zebras or gnus, and will give the alarm by starting to run. Zebras, on the other hand, will scent a lion creeping up under cover long before the ostriches will see him; and by making off will warn these birds and other duller scented members of the incongruous assemblage that danger is afoot.

AGRICULTURAL NOTES.

IN the recently published number of the *Journal* of the South-eastern Agricultural College, Wye, Mr. Theobald gives an account of some injurious flea-beetles (Halticæ) which he has recently studied. He finds that the damage ascribed to the turnip "fly" (*Phyllotreta nemorum*) is very often due to related genera. A troublesome attack of the "fly" at the College farm drew attention to a new culprit, *Haltica oleracea*, and in observations made in Yorkshire, Cambridge, Huntingdon, Surrey, Kent and Devon, this species was found to be much more destructive than *P. nemorum*. The characteristics of five injurious genera are described, and observers are asked to collect and report upon these very destructive insects. Mr. Theobald's experience leads him to remark that "The present economic entomologist relies on the past economic entomologist, and so errors go on until they really seem facts. . . . John Curtis wrote the most excellent article on the turnip flea that can be imagined, and we have all copied it." Mr. Theobald's request for "serious reporting and collecting" should appeal to a wider circle than is reached by the College *Journal*. The entomologist is not the only worker who relies on the achievements of the past, nor is economic entomology the only branch of applied science that may learn something from this study of the Halticæ.

In the same number Principal Hall, until recently head of the College, summarises the results of manurial experiments on the hop, which have been carried on at various centres for from three to eight years. He concludes that the hop plant is "an all-round feeder," in this respect differing from such crops as swedes, which depend mainly on phosphates, and from potatoes, which must be liberally dressed with potassic manures. No one special manure can

be recommended to hop-growers; the first point in successful management must be to ascertain and make good the manurial deficiencies of the particular soil. In some cases phosphates, and in others potash, may be found profitable as an addition to a dressing of a nitrogenous manure. Specific instructions are given for the manuring of the Farnham hop soils.

To part i. vol. v. of the *Journal* of the Khedivial Agricultural Society, one of the editors, Mr. E. P. Foaden, contributes an article on "Manures in use in Egypt." With the rapid advances made in the material welfare of the country, and the increased use of irrigation, there has been "an extraordinary increase in the value of land," and the subject of suitable manures for use in intensive cultivation is a pressing one. Nile mud, upon which the cultivators have so largely depended in the past, has been proved by experience to be insufficient, and by analysis to lack nitrogen, though supplying an abundance of potash for most, and of phosphate for many, crops. The supply of farmyard manure is very inadequate. In Egypt as in India, the lack of wood leads to the use of dried cow-dung cakes for fuel. Pigeon manure forms a concentrated fertiliser extensively used in Upper Egypt, and dried sewage is becoming popular. Two interesting natural products are mentioned; one, *Coufri*, is a manure collected on ancient village sites, but it is of low quality, seldom containing more than 0·5 per cent. of nitrogen; the other, known as *Marog* or *Tafia*, is a blue clay or a marl found in hills in the deserts in Upper Egypt. This is an important manure in common use in parts of Upper Egypt, and of great value to the country. Analyses of seven samples are quoted, and these show that *Marog* contains notable quantities (from 2·5 to 24 per cent.) of nitrate of soda, associated with which is common salt. The percentage of salt in the analyses quoted varies from 6·8 to 21·5, but there is no constant relation between the salt and nitrate of soda. It is suggested that *Marog* might be treated so as to yield commercial nitrate of soda. In its present crude form the heavy cost of transport prevents the use of *Marog* in Lower Egypt. The article deals briefly with common artificial manures such as nitrate of soda, sulphate of ammonia and superphosphate, all of which are now being imported into Egypt for application to cotton, sugar-cane, and the more valuable cereal and market-garden crops.

When the "Sale of Milk Regulations" came into force in September, 1901, the standard of 3 per cent. fat and 8·5 per cent. non-fatty solids required by the Board of Agriculture was regarded as being very low, and the opinion was freely expressed that the milk of well-fed, healthy cows was rarely so poor in quality. It has since been shown that milk is more variable in composition than was formerly supposed, and that a sample representing a single milking may frequently contain a smaller percentage of solids than is required by the Board's regulations. When milk is drawn at equal intervals, the mixed milk of a herd of cows will usually be satisfactory, but if the milk of the individual cows be tested, it will be found to show wide, and at present inexplicable, variations. On this question some experiments have recently been made by Messrs. Dymond and Bull at Chelmsford, under the auspices of the Essex Technical Instruction Committee. The experiment consisted in testing, twice daily, the milk of six shorthorn cows which were housed, fed and milked under careful supervision and under favourable conditions. Two of the cows were under observation for short periods only. The following figures show the number of times on which the milk of the others failed to reach the standard:—

	Average daily yield lbs.	No. of milk analyses	Fat deficient	Non-fatty solids deficient
Cow I. ...	30·8 ...	206 ...	8 times ...	68 times
,, II. ...	28·8 ...	206 ...	117 ,, ...	52 ,,
,, III. ...	16·6 ...	156 ...	1 ,, ...	0 ,,
,, IV. ...	18·8 ...	206 ...	0 ,, ...	0 ,,

The first two animals were in full milk, having calved six weeks before the test began; the other cows had calved eight months, and were beginning to go dry. The feeding was varied in the course of the experiments, and on several occasions the animals were exposed to low temperatures, but the milk was little, if at all, influenced. The quality depended on the cow, not on the conditions under which she was kept. The mixed milk did not fall below standard during the experiments, but the analyses given indicate that when a herd is largely composed of newly-calved cows the milk *may* frequently fall below standard.

An illustrated article in a recent number of the *Scientific American* describes scientific poultry raising as practised on the largest poultry farm in the States (at Sidney, Ohio). On this farm 3000 Leghorns supply on an average 200 dozen unfertile eggs for culinary purposes *per diem*, and 900 Plymouth Rocks produce 450 eggs daily, which the hatchery—a building 480 feet long—converts into 300 healthy chicks. The chicks, when a day old, pass to the "nursery," and spend a month in this building, which is capable of holding 6000 at a time. They then pass to a second building, where they remain until three months old. The chickens are not allowed to mix, but are divided up into small colonies, so that if anything goes wrong the mischief is prevented from spreading. The hens are provided with automatic nests, so constructed that the egg is removed as soon as it is laid; the new-laid eggs are thus collected at once, and are washed, dated, and placed in refrigerators for transport, so that they reach their destination absolutely fresh. Electric light is employed in the testing of eggs, and the progressive poultryman, assisted by the researches of the U.S. Department of Agriculture, feeds his fowls on the most approved principles. The net result of science in the poultry yard is a "marvellous development of the incubator industry" and of the poultry business. It is stated that one town in Illinois turns out more than 50,000 incubators a year. Among leading poultry farms are mentioned those of ex-President Cleveland and of President Diaz, of Mexico.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Royal Commissioners for the Exhibition of 1851 have made the following appointments to science research scholarships for the year 1903, on the recommendation of the authorities of the several universities and colleges. The scholarships are of the value of 150*l.* a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any university at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. The nominating institutions and the scholars are as follows:—University of Glasgow, A. W. Stewart; University of St. Andrews, D. McLaren Paul; University of Birmingham, N. L. Gebhard; Yorkshire College, Leeds, R. Gaunt; University College, Liverpool, J. F. Spencer; University College, London, H. Bassett; Owens College, Manchester, L. Bradshaw; Durham College of Science, T. P. Black; University College, Nottingham, G. Tattersall; University College, Sheffield, Catherine Radford; University College of North Wales, Bangor, K. J. Thompson; Royal College of Science, Dublin, S. A. Edmonds; Queen's College, Belfast, T. B. Vinycombe; McGill University, Montreal, H. L. Cooke; University of Sydney, A. Boyd. The following scholarships granted in 1902 have been continued for a second year on receipt of a satisfactory report of work done during the first year:—University of Edinburgh, J. K. H. Inglis; University of Glasgow, A. Wood; University of Aberdeen, A. C. Michie; University of Birmingham, J. A. Lloyd; Yorkshire College, Leeds, H. D. Dakin; University College, Liverpool, F. Rogers; University College, London, E. P. Harrison; Owens College, Manchester, G. C. Simpson; Durham College of Science, C. R. Dow; University College, Sheffield, G. B. Waterhouse; Queen's College, Galway, W. Goodwin; University of Toronto, W. C. Bray; Dalhousie College, Halifax, Nova Scotia, T. C. Hebb; University of Melbourne, R. Hosking; University of New Zealand, M. A. Hunter. The following scholarships granted in 1901 have been exceptionally renewed for a third year:—Yorkshire College, Leeds, R. B. Denison; University College, London, G. Owen; University College of London, Dr. G. Senter; University College of North Wales, Bangor, Alice

E. Smith; McGill University, Montreal, R. K. McClung; Queen's University, Kingston, Ontario, Dr. C. W. Dickson.

THE August number of the *Fortnightly Review* contains the ninth of the series of essays by Mr. H. G. Wells, entitled "Mankind in the Making," the subject being the organisation of higher education. Among many other important considerations, the suggestions made for "suitable arrangements of studies that can be contrived to supply the essential substantial part of the college course" are of particular interest. The first such course proposed is an expansion of the physics of the school stage, which may be conveniently spoken of as the natural philosophy course. "Its backbone will be an interlocking arrangement of mathematics, physics, and the principles of chemistry, it will take up as illustrative and mind-expanding exercises, astronomy, geography, and geology conceived as a general history of the earth. Holding the whole together will be the theory of the conservation of energy in its countless aspects and a speculative discussion of the constitution of matter." The second course "is what one may speak of as the biological course. Just as the conception of energy will be the central idea of the natural philosophy course, so the conception of organic evolution will be the central idea of the biological course. A general review of the whole field of biology—not only of the natural history of the present but of the geological record—in relation to the known laws and the various main theories of the evolutionary process will be taken, and in addition some special department, either the comparative anatomy of the vertebrata chiefly, or of the plants chiefly, will be exhaustively worked out in relation to these speculations." The other two college courses proposed are named classical and historical respectively. Of a purely mathematical course Mr. Wells writes, "few people, however, are to be found who will defend the exclusively mathematical 'grind' as a sound intellectual training, and so it need not be discussed here." Educationists who study the paper will find in it much material for thought.

THE Home Counties Nature-Study Exhibition will be held at the offices of the Civil Service Commission (formerly the buildings of the University of London), Burlington Gardens, London, W., on October 30–November 3.

MR. ANDREW CARNEGIE has presented to Dunfermline, his native town, the sum of half a million sterling in Steel Trust bonds, to be employed, among other purposes, for the advancement of technical education in the district, which is the centre of the linen industry in Scotland.

M. ANDOYER has been appointed professor of physical astronomy, and M. Painlevé professor of general mathematics, at the University of Paris. M. Padé, of the University of Poitiers, has been appointed professor of mechanics at the University of Bordeaux, and M. Lebœuf professor of astronomy at the University of Besançon.

THE opening address of the Edinburgh summer meeting was delivered on August 4 by Sir John Murray, who reviewed the history of the meetings, and explained that this year the special subject for study was Edinburgh and its region. The chief object of the course of study arranged was to train teachers of nature-study in accordance with the present requirements of English and Scottish schools. Sir John Murray gave it as his opinion, at the conclusion of his address, that "the great battles of the future would be not between man and man, but a struggle for possession of the forces of the earth; and no nation could hope to keep in the forefront if it were not continually making additions to the sum total of human knowledge."

AN Agricultural Education Bill was introduced in the House of Commons by Mr. Collings on August 6. It is similar to the one which passed the second reading in 1895. The object of the Bill is to provide for the teaching in elementary schools of agricultural and horticultural subjects, to give facilities for nature-studies, and generally to cultivate habits of observation and inquiry on the part of the pupils. To this end the Bill provides for school gardens and such collections of objects as may be necessary for practical illustration. The education specified in the Bill is to be compulsory in all schools in rural and semi-rural districts. The Bill cannot be proceeded with this session.

THE prospectus of the Department of Education at Owens College, Manchester, for the session 1903–4, has now been published, and gives full particulars of the courses of training provided for teachers in primary and secondary schools. The instruction received by primary school teachers is for the most part of an undergraduate standard, while that for teachers in secondary schools is of a post-graduate character. Special lectures are provided for those who are already engaged in teaching, and opportunities will be offered of individual study and research in education without reference to any preparation for a diploma or certificate. Among the public lectures arranged in connection with the department are one by the new Sarah Fielden professor—Dr. Findlay—on training for the teaching profession, and one by Prof. M. E. Sadler on the need for scientific investigation in education.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 18.—"Separation of Solids in the Surface-layers of Solutions and 'Suspensions.'" Preliminary Account. By W. **Ramsden**, M.A., M.D., Oxon., Fellow of Pembroke College, Oxford.

In this paper it is shown that the free surfaces of a large number of colloid solutions become coated with solid particles derived from the solutions under conditions excluding evaporation, or chemical change due to the gases in contact with the free surfaces. This is the case not only with proteid solutions of every kind, but also with solutions of certain aniline dyes, soaps, saponin, methyl orange, colloid ferric hydrate, &c. These surface coatings give rise to an intense viscosity confined to the surface layers and absent from the bulk of the solutions. In some cases the solid particles become mutually coherent to form a solid membrane, and then cause an intense superficial resistance to "shear." A magnetised needle floating on the surface of a colloid solution as limpid as water may be in some cases so rigidly fixed that it rotates the vessel containing the solution if this be suspended by a thread and a magnet be brought near.

By simple mechanical means, adapted to produce heaping up of any surface coatings, masses of solid material can be separated from all these solutions—in some cases when they contain only one part of dissolved solid in a million. Various solids can in this way be completely removed from solution without filtration, addition of chemicals, or necessary alteration of temperature. The "mechanical coagula" described by the author some years ago are simply heaped-up surface membranes of solid proteid.

These accumulations at the free surfaces are explained by the observation that the dissolved substances are always such as possess the property of diminishing the surface-tension of the free surface of water. The most stable mechanical arrangement of such solutions must involve a relative concentration of the dissolved substance at any surfaces the surface-tension of which can be thereby diminished, and in some cases the formation of a coating of de-soluted solid completely separating the solution from the adjacent medium.

Every limpid solution capable of forming unusually persistent thin films or bubbles yields solid or highly viscous "mechanical surface aggregates," and is therefore regarded as having a surface coating of solid or highly viscous matter. On some of these bubbles the presence of a coherent surface membrane can be directly demonstrated by their behaviour on collapse. Unusual persistence of a thin film derived from a limpid solution is invariably associated with the presence of solid or highly viscous particles on its free surfaces. Particles of this nature and in this situation would act partly by serving as *points d'appui*, partly by offering mechanical resistance to deformation of the surface, and partly, in virtue of their effect upon the "surface energy," by calling out resistance to such deformation as would expose a fresh surface of greater "surface-tension."

Precisely similar phenomena are met with at the interfaces of certain immiscible liquids one of which is a solution, and the great persistence of many emulsions is due mainly to the accumulation of solid or highly viscous particles at the interfaces of the two liquids.

Superficial resistance to "shear," the capability of yielding "mechanical surface aggregates" and "coagula," the possession of marked bubbling-power, and the formation of very persistent emulsions by certain limpid liquids, are all explained as due to the accumulation of certain substances in a solid or highly viscous condition at the surfaces concerned, and to the physical properties of the matter thus accumulated.

PARIS.

Academy of Sciences, August 3.—M. Albert Gaudry in the chair.—The relations between multi-fluid batteries, by M **Berthelot.**—Remarks concerning the relations between batteries formed of the same liquids, between two different or identical electrodes, by M. **Berthelot.**—On a double carbide of chromium and tungsten, by MM. Henri **Moissan** and A. **Kouznetzow.** A double carbide of chromium and tungsten of the formula $CW_2.3C_2Cr_3$ has been prepared by two different methods. It is similar to analogous compounds indicated by MM. Carnot and Goutal as existing in metallurgical products. The carbide is very stable, not attacked by acids or by ordinary reagents, and is remarkable for its extreme hardness, scratching quartz and topaz with ease. It is possible that this compound may be formed by the addition of tungsten to chrome steels, and may be the cause of some of the special properties of these steels.—Does arsenic exist in all the organs of the animal economy? by M. Armand **Gautier.** A review of the work done on this question since the author's first memoir in 1899, together with a minute study of the influence of arsenic in the reagents on the results.—The addition of hydrogen to aldehydes and ketones by catalysis, by MM. Paul **Sabatier** and J. B. **Senderens.** The direct action of hydrogen in presence of reduced nickel at a low temperature readily transforms aldehydes and ketones into the corresponding alcohols. The method possesses the advantage of furnishing the alcohols free from secondary products, and in high yields.—The residue of secular perturbations, by M. Jean **Mascart.**—On quasi-periodic functions, by M. **Esclangon.**—On the functions of *n* variables represented by series of homogeneous polynomials, by M. H. **Dulac.**—On the integrals of S. Lie, by M. N. **Saltykow.**—On the changes in phase resulting from the normal reflection in quartz on silver, by MM. J. Macé **de Lepinay** and H. **Buisson.**—A description of an instrument designed to measure accurately the optical constants of microscope objectives and eye-pieces, by M. V. **Legros.**—On telekine, by M. L. **Torres.** The name telekine is applied by the author to a system of a spring and governor, controlled from a distance by wireless telegraphy. Among the applications suggested by the author as possible are the direction of submarine torpedoes and of balloons.—New laws of tonometry, deduced from Raoult's experiments, by M. E. **Wickersheimer.**—Pressure curves of univariant systems containing one gaseous phase, by M. A. **Bouzat.** Four groups of univariant systems are distinguished, for which it is found that the ratio of the absolute temperatures corresponding to a given pressure in any two systems of the same group is constant for any value of the pressure. This is equivalent to the proposition that the variation of entropy resulting from the liberation of one molecule of gas under a given pressure has the same value for all systems in one group.—The estimation of pyridine in aqueous solution, by M. Maurice **François.** The method is based on the formation of the chloroaurate, $C_5H_5N.HCl.AuCl_3$, and its insolubility in ether. The chloroaurate is ignited, and the amount of pyridine deduced from the weight of gold left.—On secondary amides, by M. **Tarbouriech.** By the action of acid chlorides upon primary amides in sealed tubes at 110°–115°, several mixed secondary amides have been prepared, the physical and chemical properties of which are given.—The reduction of the ethereal salts of acids of complex function, by MM. L. **Bouveault** and G. **Blanc.**—The action of phenyl hydrazine on alkyl bromides and iodides, by M. J. Allain **Le Canu.**—Thermochemical researches on colouring matters. Rosaniline and pararosaniline, by M. Jules **Schmidlin.**—On the estimation of ammonia in wine and its use in differentiating *mistelles* from liqueur wines, by M. J. **Laborde.**—On the salol ferment present in certain samples of milk, by M. A. **Desmoulière.** Remarks on a paper on the same subject by MM. Miele and Willem.—On the properties and chemical composition of the phospho-organic reserve material of plants containing chlorophyll, by M. S. **Posternak.** It is shown that the phospho-organic reserve material of green plants possesses characteristic properties by means of which it can be easily differentiated from other phosphorus compounds already known.—Excretion in hydroids, by M. A. **Billard.**—The mechanical laws in the development of the skull of Cavicornes, by M. U. **Duerst.**—The digestive apparatus of the Silphidæ, by M. L. **Bordas.**—On the Heteropods collected during the voyages of the *Hirondelle* and the *Princesse Alice*, made under the direction of the Prince of Monaco, by M. A. **Vayssière.**—Sections of the Tertiary strata of Patagonia, by M. André **Tournouër.**—On the geological constitution of the district of Mirsa Matrouh, by M. D.-E. **Pachundaki.**—The sensitisers of the tubercle bacillus, by MM. J. **Bordet** and O. **Gengou.**

NEW SOUTH WALES.

Royal Society, June 3.—Mr. F. B. Guthrie, president, in the chair.—Language of the Bûngandity Tribe, South Australia, by Mr. R. H. **Mathews.** The paper dealt with the grammatical structure of the aboriginal tongues of the tribe. The author also briefly referred to the social organisation of South Australian tribes from the Lake Eyre basin to Port Lincoln and Mount Gambier.—Notes on tide gauges, with description of a new one, by Mr. G. H. **Halligan.** The author gave a brief history of the development of the automatic tide recorders, and exhibited a new gauge of his own design.

CONTENTS.

THURSDAY, AUGUST 20, 1903.

RIVER IMPROVEMENT.

The Improvement of Rivers. A Treatise on the Methods Employed for Improving Streams for Open Navigation, and for Navigation by means of Locks and Dams. By B. F. Thomas and D. A. Watt, U.S. Assistant Engineers, Members Am. Soc. C.E. Pp. xiv+356. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 25*s*. 6*d*. net.

IN their preface the authors state that they know of no recent book which treats of the improvement of rivers except in a general way, possibly because they seem not to be aware of the existence of a book, "Tidal Rivers," published in 1893, and have not apparently heard of the issue of a second edition in 1896, rewritten and enlarged, of "Rivers and Canals," from the first edition of which, published in 1882, they quote a long extract on the principles which should govern the improvement of tidal rivers. Undoubtedly, if the authors of these two books had confined their attention to the rivers of the United Kingdom, there would have been little matter in them properly applicable to American practice, owing to great differences in the physical conditions of the two countries; but both these books range over a very wide field, and deal with the improvement of rivers in various parts of the world, including, of course, rivers in the United States. Though, however, there is not such a complete dearth of books describing the methods of improvement of rivers with extensive basins, as the authors intimate in their preface, and on account of which they express the hope that their book will supply a much needed want, it is certain that the detailed descriptions of American methods and experience relating to the regulation and canalisation of large non-tidal rivers, will be of great service, not merely to those engaged in such works in the United States, but also to all engineers who have to deal with large problems of river improvement in countries containing vast drainage-areas, as met with in eastern Europe, Asia, Africa, and Australia, as well as in North and South America.

The largest river-basin of the United Kingdom, that of the Thames, with an area of only 5244 square miles, owing to the comparatively restricted extent of the British Isles, sinks into insignificance when compared with the Mississippi, having the largest drainage-area of the rivers of North America, amounting to 1,244,000 square miles, which, in its turn, is exceeded by two river-basins in South America, namely, the La Plata with a basin of 1,600,000 square miles, and the Amazon with a basin of about 2,250,000 square miles, the largest in the world. Accordingly, there is little scope in the United Kingdom for regulation works, and even for canalisation, which have enabled inland navigation to be considerably improved and extended along the large rivers of North America. On the other hand, there have not been the same opportunities in America for the great increase in depth of small tidal rivers, by dredging and training works, affording access to seaports, as has been effected in Great Britain in the Tyne, the Clyde, and the Tees, though access for sea-going vessels has been extended from Quebec to Montreal by dredging in the St. Lawrence; whilst the most important works carried out in the United States at the outlet of a river, are the parallel jetties which were constructed several years ago in extension of the South Pass of the tideless and deltaic Mississippi, across the bar encumbering its mouth, in order to concentrate the scour over the bar and thus deepen the outlet channel.

The authors deal very briefly with the improvement of river outlets in a single chapter of only ten pages, stating that this important subject would require a volume; and after quoting at full length the principles laid down by an English engineer for the improvement of tidal and non-tidal river outlets, and alluding to the experiments with working models, carried out by the same engineer, on the effects of training works in tidal estuaries, they refer to the method of improvement by jetties, and conclude with a short account of the jetty works completed at the outlet of the South Pass in 1879, and those authorised last year for obtaining a navigable depth of 35 feet at the outlet of the South-West Pass of the Mississippi. The book, accordingly, really relates to the improvement of the inland portions of large rivers for navigation by regulation works or canalisation, in which the authors, as assistant engineers in the Government Department of the United States, which has control of all the rivers, have wide practical experience, and for which the book furnishes a very valuable guide. This large quarto volume, with 349 pages of text, and illustrated by numerous pages of drawings, diagrams, and photographic reproductions dispersed throughout the book, and eighteen plates of detailed drawings at the end, together with a few blocks in the text, deals with the improvement of rivers in three distinct parts; the general characteristics of rivers and their surveys being considered in the first part, the improvement of open rivers in the second part, and the improvement of rivers by canalisation in the third part.

The first part is divided into five short chapters, occupying only forty pages altogether, treating respectively of introductory matters, the characteristics of rivers, preliminary examinations and surveys, topographical surveys and levelling, and hydrographic surveys. This part is mainly concerned with the preliminary data which require to be obtained before undertaking works of improvement, namely, the physical features of the river, consisting of the amount of the rainfall and the size of the river-basin, the fall and nature of the river-bed, the sediment brought down, shoals, bars, and changes in water-level; next, surveys of the course of the river; and, lastly, cross-sections of the channel, and measurements of the discharges over weirs and in the unimpeded channel.

The second part is divided into seven chapters, and covers ninety-one pages, dealing successively with the "Removal of Bars and other Obstructions," "Regularisation," "Dykes and their Effects," "Protection of Banks," "Levees," "Storage Reservoirs," and "Improvement of River Outlets." The first of these chapters relates to the various devices attempted

for stirring up the materials of bars and shoals so as to effect their removal by the current, the different types of dredgers and their capabilities, and the clearing away of trunks of trees, termed snags, and wrecks from the navigable channel. The most interesting work in this respect is the formation each year, during the low stage of the Mississippi, of a channel for navigation, about 250 feet wide and 9 feet deep, across sandy shoals in certain places by suction dredgers, the efficiency of which is increased by stirring up the sand with water-jets; and in 1899 five of these dredgers cut about 62 miles of channel at the average rate of 105 lineal feet per hour. The second chapter of this part lays down the general principles on which the regulation of river channels is based, with the object of obtaining greater uniformity of depth; whilst the following chapter describes the construction of spur and longitudinal dykes, which are sometimes submerged, by which the regulation is effected, a system which has been successfully applied to several of the larger rivers of Europe, as well as in America.

The protection of banks aims mainly at the prevention of prejudicial changes in the course of a river by the erosion of the concave banks in flood-time; and it is accomplished by pitching, rubble stone, fascines, brush mattresses, or occasionally submerged spurs. Levees, consisting of earthen embankments, formed along the banks of a river to prevent the river from inundating the riparian lands in flood-time, are rather works for the protection of property than for river improvement; but to effect their purpose they must be watertight, continuous, and have their tops above the highest floods, which necessarily have their water-level raised by being confined within the banks. Several rivers in Europe have been controlled by embankments, notably the Po, the Loire, and the Theiss; and levees have been extensively carried out on the Mississippi below Cairo and some of its tributaries, the total expenditure on these works in the United States being estimated at about 10,000,000*l*., up to the present time, for a length of 1436 miles; whilst considerable additions to the Mississippi levees are projected. These embankments, however, are liable to be occasionally overtopped and breached by an exceptional flood; and in alluvial plains, as in the case of the Mississippi, they are exposed to undermining by changes in the course of the river, in spite of regulating works; and the rush of water through the gap formed in the bank produces considerable devastation over the adjacent low-lying lands. Rivers bringing along large quantities of detritus in their torrential flow down steep mountain slopes, and abruptly emerging into flat plains, are liable to raise their beds by the deposit of sediment, owing to loss of velocity, when confined within embankments, a result which occurs in the Yellow River of China and some Japanese rivers; and under such conditions, when the embankments are successively raised to compensate for the rising of the river-bed, a terrible catastrophe is a mere question of time, due to the precipitation of the raised and imprisoned river through a weak place in the embankments, with irresistible force and rapidity, into the plains below.

The chapter on "Storage Reservoirs" consists almost entirely of extracts from a report by Captain Chittenden on "Reservoir Sites in Wyoming and Colorado," a method of compilation employed in several of the earlier chapters, though to a minor extent, and also in the following chapter on river outlets, already referred to. Reservoirs would be valuable in river valleys in serving, like lakes, for regulating the flow of rivers by reducing the flood discharge and augmenting the low-water flow. It is, however, only under exceptional conditions that reservoirs can be formed extensive enough, at a reasonable cost, to increase materially the flow of a river at its low stage; but this has been accomplished by damming the outlets of some lakes near the sources of the Volga and Msta in Russia, extending the navigable period of those rivers by nearly three months; whilst a similar improvement has been effected in the Upper Mississippi by raising the water-level of several lakes near the head-waters of the river, a system which might be considerably extended in this case, owing to the immense number of lakes existing near its sources. The formation of reservoirs at intervals along a river valley would greatly reduce the flood discharge by impounding the flood-waters, but the conditions are rarely favourable; and the cost of construction, and the extent of land submerged, present insuperable obstacles to the adoption of this system, merely for the mitigation of floods, in the great majority of cases. Several reservoirs, however, have been constructed in Europe for storing up water for water-power for industrial purposes, as well as for the mitigation of floods, with successful results, as, for instance, the Furens and Ternay reservoirs in France, and the Dahlhausen reservoir on the Wappen in Germany, the provision for floods being effected by keeping the reservoir drawn down to a definite extent below its full water-level for their reception.

The third part, relating to the canalisation of rivers, occupies one hundred and forty-one pages, or rather more than half the regular text of the book, and is divided into ten chapters, the three first dealing with locks and lock gates, the fourth with fixed dams on rivers, and the remainder with the various types of movable weirs, which constitute the more novel and most interesting portion of the subject. Though the first movable weir appears to have been the bear-trap weir erected in 1818 across the Lehigh River in the United States, consisting of two gates or shutters turning on horizontal axes on the sill, and one resting on the edge of the other, the principal types of movable weirs were gradually introduced in France between 1834 and 1885; and most of these French forms have been reproduced, on a larger scale, on some of the rivers of the United States; whilst the American bear-trap weir was adopted, with improvements, at Laneuville-au-Pont on the River Marne, in France, about the middle of the nineteenth century.

The object of these movable weirs is to leave the channel of a river quite unimpeded in flood-time for the passage of the flood discharge, and occasionally of vessels when the lock is submerged, whilst retaining the water-level of the river above it at a sufficient height for navigation in dry weather; and the three chief French types are the Needle Weir, the

Chanoine Shutter Weir, and the Drum Weir. The needle weir consists of a series of wooden spars resting against a bar at the top across the weir, carried on a row of iron frames providing a foot-bridge, and against a sill at the bottom, though of late years sliding panels or rolling-up curtains have been often substituted for the spars or needles; and this type of weir has been adopted for the first time in the United States for a weir across the Big Sandy River at Louisa, in Kentucky, with large inverted V-shaped frames placed 8 feet apart, and lying one inside the other when lowered on the apron in flood-time, and closed by needles having the exceptional dimensions of 12 inches width, 14 feet length, and 8½ inches thickness at the bottom and 4½ inches at the top, which are handled by a floating derrick. The frame weir suspended from an overhead bridge, so that all the movable parts can be raised out of the river in flood-time, as resorted to on the Lower Seine at Poses and Port-Mort, and the barriers substituted for needles, are described and illustrated in the book, but have not hitherto been adopted in the United States.

The Chanoine shutter weir is composed of a series of shutters supported centrally on a trestle, and turning on a horizontal axis, the trestle being maintained in an upright position by a prop, resting at its lower extremity in a cast-iron shoe fixed to the apron when the river is closed; and the weir is opened by withdrawing the props from their shoes, causing the trestles to fall flat on the apron, with the shutters on top of them in a horizontal position. Owing to the rapidity with which it can be opened, this type of weir is advantageous for rivers subject to sudden floods; and it has been adopted in the United States across the deep navigable passes on the Ohio and Kanawha Rivers, where shutters somewhat larger than the biggest in France have been erected.

The drum weir consists essentially of an upper and an under paddle revolving on a central horizontal axis, the row of upper paddles forming the weir; and the under paddles, revolving in the quadrant of a horizontal cylinder forming the drum, are made to close or open the weir by altering the water-pressure on their two sides in the drum, so that when the head of water from the upper pool presses on the upstream side of the under paddles, the upper paddles rise against the current of the river. In spite of the perfect control of this weir which the under paddles afford, the deep foundations required for these paddles below the sill, exceeding the height of the weir above it, have hindered its general adoption; and since the completion, in 1867, of a series of these weirs in the canalisation of the Marne, a tributary of the Seine, they have only been used in Europe for timber passes at the side of the weirs erected across the River Main for canalising it in 1883–6, and across the navigable pass, 9 feet in depth, of the Spree at Charlottenburg. A modified form of drum weir has been quite recently constructed in timber across the Osage River in Missouri, in which the paddles are replaced by a sector of a cylinder which fits exactly in the drum when lowered, and closes the weir when raised. The old bear-trap weir fell into oblivion for many years in America; but within the last few years some weirs of this type, of improved design, have been constructed; and two, placed alongside a new weir near Beaver on the Ohio River, each 120 feet long and 13 feet high, serve for the passage of drift and for regulating the discharge.

Another peculiar, novel type of weir, also forming part of the new weir across the Ohio, consists of a series of A-shaped frames, which, as in other frame weirs, can be lowered flat on the bed of the river in flood-time; but it differs from ordinary frame weirs in the frames themselves forming the barrier for closing the weir, by being constructed with a widened plated upstream leg touching the plates of the legs of the adjacent frames when standing upright, besides furnishing a support for the foot-bridge along the top of the weir.

The book concludes with three appendices, giving the dimensions of various locks and weirs in the United States, the standard specifications adopted for certain river works and materials, and laws for protecting the waterways in the United States. Altogether, the book affords a large amount of information about works carried out on rivers under Government in the United States; whilst in some of the chapters, such as those on levees, storage reservoirs, and more especially those on movable weirs, interesting particulars are also given of European works.

THE FISHERMAN IN AMERICA.

Bass, Pike, Perch, and Others. By James A. Henshall. Pp. xix+410. (New York: the Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 8s. 6d. net.

Big Game Fishes of the United States. By Chas. F. Holder. Pp. xiv+435. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 8s. 6d. net.

THESE two volumes of the "American Sportsman's Library" deal with the fishes of the United States, other than salmon, trout, and char, from the sportsman's point of view. Although the same ground is to a certain extent covered by both, Dr. Henshall has to deal with numerous species inhabiting both fresh and salt water, while Mr. Holder's volume confines itself to a comparatively small number of marine species, and this naturally results in the adoption of a different method of treating the subject by the two authors; this much they have in common, that both have produced books which give the angler information as to the tackle to be employed for each species and the places in which to employ it, and at the same time illustrate their remarks with excellent personal observations on the habits of the fish with which they deal.

The first book under notice combines in a greater degree than almost any other work of which we are aware, systematic ichthyology and directions to the fisherman; the author has adopted the classification of Jordan and Evermann's "Fishes of North and Middle America," and his specific descriptions and most of his nomenclature are taken from that standard work, with the addition of useful observations of his own upon the

specific differences between allied species. While welcoming the restoration of Esox as a generic name for the pike—in consonance with Jordan and Evermann's own most recent work—one rather regrets that the author has not reconsidered the reasons which have caused American writers to separate the graylings from the Salmonidæ as a separate family, and to substitute Stizostedium for the Lucioperca of European authors.

The reader of this book is immediately struck by the great difference between the American and European fish fauna as viewed by the fisherman; among fresh-water forms the only Cyprinoid fish considered in any other light than as prospective bait is the introduced *Cyprinus carpio*, while the place occupied in England by Cyprinoids is taken by numerous species of Percidæ and Centrarchidæ, the only representatives of which in our waters are the common perch and the ruff. From the angler's point of view this is no slight gain, especially as some of the Centrarchidæ, notably the two species of "Black Bass," attain a large size and rise freely to an artificial fly. Justice is also done to the merits of the grayling, but hardly, we think, to the views of either English anglers or poets respecting it. Among the marine fishes, again, our American friends have very many Serranoid and Sciænoid fishes to set against our bass, and numerous Sparoids where we have but one sea bream that can be considered an "angler's fish," but we find the grey mullets only mentioned as bait for other fish, and no species of Gadoid even mentioned. Mr. Holder is surely right, and the coalfish (the "pollack" of American writers) has not yet met with the recognition it deserves as a sporting fish.

It is, perhaps, hypercritical and unfair to complain of such a matter, but Dr. Henshall's language, especially in dealing with technical descriptions of tackle and gear, is not very intelligible to an Englishman, more especially when the great differences between English and American rods and lines are taken into account; it is a little startling to find an eight ounce rod recommended for pike fishing and puzzling to find no details as to the length and build of such a rod. A "chlorinated sea breeze" is apparently a special product of the western Atlantic, like the author's Bahama negro, for whose observations on fishes and their ways all Dr. Henshall's readers will be grateful.

We are reminded of a certain traveller's tale about a "mixed bag of wild fowl and hippopotami" when dealing with Mr. Holder's "Big Game Fishes," almost on the same line with Dr. Henshall's work; we pass from the grayling and the perch to the huge Serranoids of the Florida and California reefs, the tarpon, and the pelagic Scombridæ, the weights of which are reckoned by the hundredweight, and we pass, too, to descriptions of some of the most exciting fishing man can want. Unfortunately, the English sea fisherman must content himself with smaller game (unless he chooses to fish for the blue sharks, which are common enough off our western shores in the late summer), but a work like this should find readers outside the United States; the tunny and the albacore are within reach of British fishermen in the Mediterranean, the American tarpon has its counterpart in the Indian Ocean, and huge Serranoids are not confined to American waters. If English or colonial readers should feel encouraged to try their hands at "big game fishing," they will find in Mr. Holder's book all the information they can desire as to the necessary tackle and baits to use, and the kind of place in which to use them, and if Mr. Holder's descriptions of this exciting form of sport do not encourage them to try their hands at it, we really do not know what will.

In marked contrast to Dr. Henshall, Mr. Holder gives no specific descriptions of the fish he deals with, and his only attempt at systematic or anatomical detail in his introductory chapter is not very happy; no reason is given for terming the shark "not a true fish," and to dismiss so important a structure from a systematic point of view as a fish's pectoral arch by saying that "many of the corresponding bones among higher animals are seen, as a pectoral arch, scapula, clavicle, ulna, and radius," is neither useful nor accurate.

The printing and get up of both books is excellent, and both are well illustrated, the one in black and white, the other in colours; the only fault to be found is that the process blocks of fishes have lost in clearness by being printed on rather too rough a paper, and that the figure of Pseudopleuronectes in Dr. Henshall's book is printed upside down; there are also in Mr. Holder's book certain references to a non-existent Fig. 9, which are apparently due to an oversight. The index in each case is very good. L. W. B.

TECHNICAL PHYSICS.

Lehrbuch der technischen Physik. By Prof. Dr. Hans Lorenz. Erster Band. Technische Mechanik Starrer Systeme. Pp. xxiv+625. (Munich: Oldenbourg, 1902.)

THIS book is interesting as the work of an engineer who is also a professor in one of the leading universities of Germany, where it is generally conceded that the science and practice of technical education are best understood, and have led in modern times to the most striking practical and commercial developments. The author rightly considers the fundamental principles of mechanics to be the groundwork of all physics, and has chosen mechanics as the subject of his first volume.

The most striking features of the book, as a whole, are the rigorous mathematical method of treatment adopted, the generality of the principles discussed, and the logical order of the arrangement. In an English "technical" text-book we should rather expect to find the practical applications in the foreground, and the general mathematical treatment of the principles either absent, or introduced only so far as was necessary for purposes of calculation, and not as the groundwork of the whole arrangement. Owing to the difficulty which many students find in appreciating general mathematical reasoning, we are inclined to make the mathematics as concrete and "practical" as possible, and to restrict it to the immediate applications required for illustrations. No doubt this may produce the best results, on the whole, in the case of

students whose abilities and opportunities are limited; but such students will probably not possess sufficient grasp of the mathematical principles to enable them to apply their knowledge to any new problem. Their training is "technical" in the English sense of the term. It may be questioned whether the German view of technical physics, as understood by the author of the present work, is not really the wiser and the more likely to lead to sound educational and commercial progress in the end.

The book begins with a general chapter on the geometry of motion. The idea of time is introduced in the next chapter on velocity and acceleration. This is followed by a chapter on relative motion, treating the usual examples, such as projectiles, planets, pendulum, oscillations, &c., in a very general manner. In chapter iv. we have mass and force introduced together with friction, damped oscillations, impact, work, and kinetic energy. In chapters v. and vi. we have a general discussion of the equations of motion in a plane, and in three dimensions, respectively, with a number of important applications, such as the theory of the precession of the earth's axis, the centrifugal governor, and the theory of models and dimensions.

The book concludes with a historical survey of the evolution of mechanical science divided into three sections:—(1) before Newton, (2) from Newton to Lagrange, (3) the later development of technical mechanics. This historical excursus would be unnecessary, from the teacher's point of view, for the mere inculcation of the principles of the subject, and would interfere with the logical order of ideas. But from the student's point of view such a historical survey is not only extremely interesting, but also most instructive. Correct ideas can only be appreciated in their true significance by contrast with incorrect conceptions, such as abound in the earlier history of the subject; and the methods and principles at which we have arrived at the present stage of progress are not in all probability the best expression of the science, but are the outcome of an intricate process of evolution along certain lines. To appreciate them fully it is necessary to know something of the manner in which they have been evolved.

It is probable that the English engineer would hesitate before devoting much time to the study of a foreign text-book which at first sight is of so "unpractical" a nature. But the mere existence of the book in its present form suggests a lesson which our technical educators may have yet, in some cases, to learn. H. L. C.

OUR BOOK SHELF.

An Introduction to Botany. By W. C. Stevens. Pp. 428; with preface and index and key, 121 pp. and index. (New York and London: D. C. Heath and Co., 1903.) Price 6*s*.

AMONG the numerous works professing to guide the elementary student through the mazes of botanical science, this may claim several advantages, inasmuch as the greater part of the book is based on a sound conception of the method best suited for the purpose of training the beginner to observe and think for himself. It is the method which Huxley worked so hard to introduce into this country many years ago, namely, that of encouraging the student to investigate first, and then telling him more about the things he has seen, keeping the opinions and records of others in the background until he has acquired a stock of his own knowledge to work upon.

On the whole the purpose of the book is carried out, but the figures are often very poor, and the part dealing with systematic botany frankly returns to the old lines, and is, moreover, only suited to American students. Why this part should be separately paged is not clear; it necessitates a second index, and makes the book somewhat cumbrous. English students will find far better exercises in the use of analytical keys and floristic work generally in Hooker and Bentham's well-known "Flora."

Kant's Lehre vom Glauben. By Ernst Sänger. Pp. xvii+170. (Leipzig: Verlag der Durr'schen Buchhandlung, 1903.) Price 3 marks.

KANT'S philosophy has found, and continues to find, various application and still more various interpretation. The diversity of commentaries has led, in some quarters especially, to a feeling that Kant has received enough development, that in some cases the development has been too much controlled by the ideas of later systems, that, in fact, we must go back to Kant and define more clearly our ideas of what he really said. The present essay is obviously designed to assist that process. If we except the last section, which makes reference to the relation between Kant's doctrine and theology, the entire essay is confined to collecting Kant's statements and piecing together his doctrine of belief from the original sources. The author has clearly spared no pains to make his collection of passages complete, nor has he failed to point out the significance of Kant's distinctions or his variations in the use of terms. For the purpose indicated, it was necessary to follow the historical order; the result is a monograph not, perhaps, eminently readable, but deserving study. Though the author's reference seems to be especially to that scientific theology which ever finds it a primary duty to accept or answer Kant, his essay cannot fail to be of value to all interested in philosophy. His remarks on the various passages show clearly how the doctrine of belief runs through all Kant's work, and how its elucidation throws light on the structure and purpose of all his writings. An introduction by Prof. Dr. Hans Vaihinger will doubtless appear to many an adequate recommendation. G. S. B.

Elementary Physics. Practical and Theoretical. Second Year's Course. By John G. Kerr, M.A., LL.D., and John N. Brown, A.R.C.Sc. (Lond.). Pp. 169. (London: Blackie and Son, Ltd., 1903.) Price 2*s*.

THE practical exercises here brought together are intended for young students who have already had a year's work in experimental physics. Dynamics, heat and light are the only branches of the subject drawn upon, and presumably the learner is expected to wait until his third year before he may hope to become acquainted, from his own experiments, with the fundamental principles of sound, electricity, and magnetism. The exercises are well arranged and the instructions given are sensible and helpful, and show that the authors are teachers of experience. The student is more likely to obtain good results if a simple sighting apparatus is used in counting vibrations of the pendulum, but no instructions appear to be given as to the use of one. On p. 64 the student is told to hang a 50-gram weight to a thread for use in his experiment, which necessitates handling the weight, a bad habit which the teacher should discourage as much as possible. A want of uniformity in the spelling of gram should be corrected in the next edition. But, on the whole, the book is likely to prove useful.

Among the Night People. By Clara Dillingham Pierson. Pp. xi+221. (London: John Murray, 1903.) Price 5s.

THIS is an American book, for American children, and about American nocturnal animals; but, if we are not mistaken, it will interest English children too, and may be of no small value in letting them into some of the secrets of the life of "the Night People" of the world in general. It consists of a series of stories or sketches of the doings of raccoons, musk-rats, skunks, mice, weasels, foxes, moths, fireflies, &c., told without any affectation in simple language, and with an evidently real knowledge of the habits and characteristics of these creatures, and with a gentle humour which aptly conceals the instruction conveyed. The animals are, of course, humanised to some extent, and talk the language of human beings, but this is managed with such skill, that the animal characteristics are quite adequately retained. A good example is the story of the inquisitive weasel, where a phlegmatic black-tailed skunk is made to play with most amusing effect on the lively curiosity of these little animals, which are the same all the world over. The illustrations of scenes in the dark, by Mr. F. C. Gordon, are very happily conceived and executed.

Qualitative Chemical Analysis. By John B. Garvin, B.S. Pp. viii+241. (Boston: Heath and Co., 1902.) Price 3s. 6d.

IT is rare in these degenerate days to find an enthusiast for the teaching of qualitative analysis, who regards it as "a source of joy to the majority of normal minds," and as affording "the keenest delight and satisfaction." For analysis, as it is taught, is usually an arid tract, which the student is compelled to traverse on the way to earning a grant or receiving a degree, not a fertile country which he can cultivate with profit and pleasure. Yet one is bound to confess that these pages reflect the author's interest in his subject, and leave the impression that, in the hands of such a teacher, analysis might possess the attributes he describes. This is effected by making the student discover and tabulate the reactions for himself. Thus, the mere mechanical following of directions is, to a great extent, avoided, and the student is freed from the burden of making his own observations correspond with the printed information in his text-book. For an elementary book the subject is very fully treated. It is not intended to be used without some assistance from the demonstrator, and consequently many details of manipulation are suppressed.

J. B. C.

British Rainfall, 1902. Compiled by H. Sowerby Wallis and Dr. H. R. Mill. Pp. lxxvi + 250. (London: E. Stanford.) Price 10s.

THIS valuable work, which has appeared yearly since 1860, is perhaps better known to the scientific world than any other work on meteorological subjects; it has become a unique and indispensable epitome of reference on all questions relating to the distribution of rain over the British Islands. Each year adds to its importance, owing to the longer period over which the averages extend, and the nearly constant addition to the number of stations dealt with. These now amount to about 3500, and have increased 40 per cent. during the last fifteen years. It is highly creditable to the compilers that they have been able to issue the volume six months after the close of the year, within which time every record has been carefully revised prior to publication. In addition to the usual tables, the present volume contains an exhaustive discussion of the rainfall at Camden Square for the forty-five years 1858–1902, by Mr. H. Sowerby Wallis. Illustrations and notes upon the unusual occurrences of the year 1902 greatly enhance the usefulness of the volume.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Amount of Emanation and Helium from Radium.

IN connection with the very striking experiments described by Sir William Ramsay and Mr. Soddy in NATURE of August 13, in which they have observed the presence of helium in the gases obtained from radium bromide and also the production of helium by the emanation of radium, it may be of interest to give some calculations of the probable amount of emanation and of helium produced by radium on the disintegration hypothesis, recently put forward by Mr. Soddy and myself to explain the phenomena of radio-activity.

A method of calculation has already been indicated by us (*Phil. Mag.*, May), but the data on which it was based are somewhat imperfect. A more accurate estimate can be made from the data of the amount of heat liberated by radium, recently measured by Curie and Laborde.

I have shown that the α or easily absorbed rays from radium consist of a stream of positively charged bodies, of mass about twice that of the hydrogen atom, projected with a velocity of about $2{\cdot}5\times10^9$ cm. per sec. These results have been recently confirmed by Des Coudres. These α bodies are expelled from every part of the mass of radium, but in consequence of the ease with which they are absorbed, only a small proportion of them escapes into the air. This self-bombardment of the radium probably gives rise to a large proportion of the heat which keeps the radium at a temperature above that of the surrounding atmosphere. Assuming for the moment that all of the heat is supplied by this continuous bombardment, an estimate can readily be made of the number of α bodies projected per second from one gramme of radium.

The kinetic energy of each projected body is 5×10^{-6} ergs. Since this energy is transformed into heat in the mass of radium, the number of bodies projected to give an emission of heat of 100 gr. cals. per hour—the amount determined by Curie and Laborde—can be shown to be $2{\cdot}4\times10^{11}$ per second. Now Townsend has shown from experimental data that $Ne=1{\cdot}22\times10^{10}$, where N is the number of atoms in 1 c.c. of gas at standard pressure and temperature, and e is the charge carried by an ion. The latest value of e, found by J. J. Thomson, is $3{\cdot}4\times10^{-10}$, so that $N=3{\cdot}6\times10^{19}$.

If the α bodies after expulsion can exist in the gaseous form, the volume of the gas produced (at standard pressure and temperature) is thus $\frac{2{\cdot}4\times10^{11}}{3{\cdot}6\times10^{19}}=6{\cdot}7\times10^{-9}$ c.c. per sec. or 0·21 c.c. per year. Allowing a wide margin for the possibility that only one-tenth of the heat emitted by radium is due to the kinetic energy of the projected bodies, the volume of the α particles should lie between 0·021 c.c. and 0·21 c.c. per year for each gramme of radium.

The determination of the mass of the α body, taken in conjunction with the experiments on the production of helium by the emanation, supports the view that the α particle is in reality helium. In addition, the remarkable experiment of Sir William and Lady Huggins in which they found that the spectrum of the phosphorescent light of radium consisted of bright lines, some of which within the limit of error were coincident with the lines of helium in the ultra-violet, strongly supports such a view. For as a consequence of the violent expulsion of the α particle, it

is to be expected that it would be set into powerful vibration and give its characteristic spectrum.

In the experiments of Sir William Ramsay and Mr. Soddy 30 milligrammes of radium bromide, probably about four months old, were used. If the α body is helium, the amount of helium liberated by solution of the radium in water must have been between 0·00017 and 0·0017 c.c., assuming that all of the helium produced was occluded in the mass of the substance.

There is evidence of at least five distinct changes occurring in radium, each of which is accompanied by the expulsion of an α particle. One of the products of these changes is the radium emanation. It is of interest to calculate the volume of the emanation occluded in radium when in a state of radio-active equilibrium. Taking as the simplest hypothesis that one α particle is projected at each change, the number of atoms of the emanation produced per second is 1/5 of the number of α particles, *i.e.* $1{\cdot}3\times10^{-9}$ c.c. When radio-active equilibrium is reached, it has been shown that 463,000 times the amount of emanation produced per second is stored up in the radium. This corresponds to 6×10^{-4} c.c. The maximum amount of emanation to be obtained from one gramme of radium thus probably lies between 6×10^{-5} c.c. and 6×10^{-4} c.c.

The radium emanation is the active principle of radium, for about $\frac{3}{4}$ of the activity of radium is due to it. Thus a large proportion of the radiations from radium is a direct result of the changes occurring in the very minute amount of matter constituting the radium emanation. If ever 1 c.c. of the radium emanation can be collected at one spot, it will exhibit some remarkable properties. The powerful radiations from it would heat to a red heat, if they would not melt down, the glass tube which contains it. This very rapid emission of energy, in comparison with the amount of matter producing it, would continue for several days without much change, and would be appreciable after a month's interval. The very penetrating rays from it would light up an X-ray screen brilliantly through a foot of solid iron.

E. RUTHERFORD.

Bettws-y-Coed, August 15.

Summer Lightning.

ALTHOUGH a good deal has been written on the subject of "summer lightning," it may not be superfluous to describe a display of the phenomenon which occurred here last evening on a scale far surpassing anything which it had been my good fortune to witness before. There had been several thunderstorms in the district during the previous five or six days, and a few peals were heard and heavy rain fell in the early afternoon of the day before (August 13). But the sky cleared rapidly thereafter, and the evening and night of that day were cloudless, every peak and crest standing out sharply defined in the clear air. Yesterday was still fine, but warmer and less bracing than visitors here expect. Late in the afternoon wisps of white mist began to gather round the summit of the Jungfrau, and streaks of thin cloud took shape in the higher air above the great mountain ridge that extends from the Silberhorn to the Breithorn. About 8 p.m. I noticed a faint quivering light overhead, supplemented by occasional flashes of greater brilliance and different colour. These manifestations rapidly increased in distinctness, and continued to play only along the opposite mountain-ridge, not extending into the regions beyond, so far as these could be seen from here, though I have since learnt that an independent series of flashes was seen around the Schilthorn on this side of the valley. Not a single peal of thunder was at any time audible. A long bank of cloud formed at a higher level than the summits of the mountain-ridge, and at some distance on the further side of it, so that the stars, elsewhere brilliant, were hidden along the strip of sky above the crest.

As one watched the display it was easy to distinguish more definitely the two kinds of discharge. One of them took the form of a faintly luminous reddish or pink light, which shot with a tremulous streamer-like motion in horizontal beams that proceeded apparently from left to right, as if their starting point lay somewhere about the back of the Jungfrau. These streamers so closely resembled the *aurora borealis* that, had they appeared alone, one would have been inclined to wonder whether the "northern lights" had not here made an incursion into more southern latitudes. So feeble were they when they sped across the clear sky that the stars were clearly visible through them. Sometimes they quivered on the far side of the cloud, lighting up its edges and shooting beyond it across the still unclouded blue. At other times they appeared on this side of the cloud, and showed the dark outline of the mountains in clear relief against the luminous background. They so rapidly succeeded each other that they might be said to be continuous, a faint pinkish luminosity seeming to remain always visible, though pulsating in rapid vibrations of horizontal streamers.

The brighter discharges were not only far more brilliant, but much more momentary. They had a pale bluish-white colour, and came and went with the rapidity of ordinary lightning. But they were clearly connected with the mountains, and not reflections from a series of distant flashes. Sometimes they arose on the other side of the great ridge, allowing its jagged crest to be seen against the illuminated surface of the cloud beyond, but leaving all the precipices and slopes on this side in shade. In other cases they clearly showed themselves on this side of the mountains, lighting up especially the snow-basins and glaciers with the dark crags around them. Nothing of the nature of forked lightning was observed among them. In one instance the flash or horizontal band of vivid light, a mile or two in length, seemed to shoot upward from the slope at the base of the precipices of the Silberhorn, as if it sprang out of the ground, having a sharply defined and brilliant base, rapidly diminishing in intensity upward, and vanishing before reaching half-way up to the crest.

But the most singular feature of the more brilliant white discharges was to be seen when one of the great couloirs of snow or a portion of a glacier remained for a minute or two continuously luminous with a faint bluish-white light. After an interval the same or another portion, perhaps several miles distant, would gleam out in the same way. My first impression was that this radiance could only be a reflection from some illuminated part of the cloud. But I could not satisfy myself of the existence of any continuously bright portions of the cloud. Moreover, the luminosity of the snow and ice remained local and sporadic, as if the beam of a search-light had been directed to one special part of the mountain declivity, and then after a while to another. While watching one of these patches of illumination, I noticed a bright point of light at the top of one of the basins of *nevé* on the slopes of the Mittaghorn. It quickly vanished, but soon reappeared, and then as rapidly was lost again. I thought that it was probably a star briefly exposed through rifts in the cloud, though its position seemed rather below that of the mountain-crest. Half an hour later, however, a similar bright light appeared about the same place, more diffused than the first, and having a somewhat elongated shape. Whether it was really a star seen through the distorting medium of a wreath of mist, or a form of St. Elmo's fire clinging to some peak on the precipice, could not be ascertained from its momentary visibility.

I learnt this morning that other observers who could watch at the same time the mountain ridges on each side of the Lauterbrunnen valley noticed that sheet-lightning was also playing about the Schilthorn, but quite independently of that on the Jungfrau range, the one mountain being dark, while the other was illuminated. The distance of the two electric centres from each other is between five and six miles. The whole display last evening afforded an admirably complete demonstration of the erroneousness of the notion formerly prevalent that summer lightning is only the reflection of distant ordinary lightning, and of the truth of the more recent views as to the nature of the phenomenon.

I may add that, as the lightning increased, the air, which

had previously been nearly calm, freshened into a strong breeze, which blew from the south-west down the valley, but died down after the illumination faded away. The cloud above the mountain began to assume irregular dark cumulus shapes, and the sky became generally overcast. Early this morning rain was falling heavily. The mountains have been all day shrouded in dripping cloud, and the deluge still continues. ARCH. GEIKIE.

Mürren, August 15.

A Mirage at Putney.

PERHAPS the phenomenon of mirage is not sufficiently rare in England to make its occurrence noteworthy, but I should like to mention a singularly beautiful example that I noticed on Sunday last (August 16). I was riding on my bicycle along the Upper Richmond Road towards the west, and against a fairly steady breeze, and had arrived at that part of the road lying between the railway bridge and the Putney High Street—about opposite house No. 110—when I noticed that the road beyond, some fifty yards in front of me, was apparently flooded ankle deep in water. I was somewhat disconcerted at the prospect of riding through such a quantity of water, but I found to my astonishment that when I arrived at the supposed lake the road was perfectly dry. I thereupon turned and rode back to my previous station, and, dismounting, watched the phenomenon for some while. To assure myself that it was no personal illusion upon my part, I directed the attention of a passing stranger to the scene, and he was impressed as I had been. I should mention that the road sloped slightly downhill from me, and the sun was high (12.50 p.m.) above on my left. The line of sight must therefore have met the dividing surface between the layers of hot and cold air lying above the wooden paving almost at grazing incidence. The surface of the "water" was still, and the reflection of the gay dresses and sunshades of the ladies just from church was remarkably and beautifully clear. H. E. WIMPERIS.

London, S.W., August 17.

THE SOUTHPORT MEETING OF THE BRITISH ASSOCIATION.

SECTIONAL ARRANGEMENTS.

THE arrangements of the various sections of the British Association for the forthcoming meeting at Southport have now been practically completed. The following summary shows the chief points of the programmes, so far as they are at present known:—

Mathematical and Physical Sciences.—The physical portion of Section A will be mainly occupied in discussing three questions of considerable interest to physicists at the present time. The nature of the emanations from radio-active substances will be introduced as one of the subjects for discussion by Prof. Rutherford, of Montreal, and it is expected that several visitors from the Continent will take part. Mr. Swinburne will introduce a discussion of the method of treatment of non-reversible processes in thermodynamics, in which Prof. Perry and others will have something to say, and Prof. Henrici will direct attention to the desirability of introducing vectorial methods into physics to a much larger extent than has been done hitherto. The fact that the International Meteorological Congress meets at Southport under the presidency of Prof. Mascart, of Paris, at the same time as the Association, will make the work in the department of Section A devoted to meteorology and astronomy of special importance this year. Contributions to the proceedings of the department have been promised by several of the members of the congress, including Hildebrandsson, Paulsen, and Pernter, and Sir Norman Lockyer will discuss the agreement in time between certain solar and terrestrial phenomena. Papers have been promised by Prof. Turner, Dr. W. J. S. Lockyer, the Rev. A. L. Cortie and Mr. Hinks, and there will be an exhibition of photographs from the Yerkes Observatory.

Chemistry.—In his opening address to the section, the president, Prof. W. N. Hartley, F.R.S., proposes to give a brief account of twenty-five years' work in spectroscopy applied to the investigation of the composition and constitution of terrestrial substances, both organic and inorganic, and to review the present position of spectroscopy chiefly in relation to chemical theories, indicating where it may be usefully and profitably extended. The following papers will be read:—"Dynamic Isomerism," by Dr. T. M. Lowry; "Hydroaromatic Compounds," by Dr. A. W. Crossley; "The Cause of the Lustre produced during the Mercerising of Cotton," by Mr. J. Hübner and Prof. W. J. Pope, F.R.S.; "Mutirotation, and the Glucoside Formula of Glucose," by Dr. E. F. Armstrong; "A Contribution to the Constitution of the Disaccharides," by Mr. T. Purdie, F.R.S., and Dr. J. C. Irvine; "Some Derivatives of Fluorine," by Miss Ida Smedley; "Fluorescence as Related to the Constitution of Organic Substances," by Dr. J. T. Hewitt; "The Cholesterol Group," by Dr. R. H. Pickard; "On Essential Oils," by Dr. O. Silberrad; "Freezing Point Curves of Binary Compounds," by Dr. J. C. Philip; "Action of Diastase on the Starch Granules of Raw and Malted Barley," by Mr. A. R. Ling; "Action of Malt Diastase on Potato Starch Paste," part i., by Mr. B. F. Davis and Mr. A. R. Ling; "Action of Malt Diastase on Potato Starch Paste," part ii., by Mr. A. R. Ling; "Some Properties of Sodium Hydride," by Mr. A. Holt; "On a Method of Separating Cobalt and Nickel and the Volumetric Determination of Cobalt," by Mr. R. L. Taylor; "The Influence of Small Quantities of Water in bringing about Chemical Reaction between Salts," by Dr. E. P. Perman; "Sur le Spectre du Silicium" and "Sur les Procédés de Photographie Spectrales applicables à la Pratique des Laboratoires de Chimie," by M. le Comte Arnaud de Gramont. Dr. W. A. Bone will open a discussion on the general subject of combustion by a paper on the combustion of methane and ethane.

Geology.—The following papers have been promised in this section:—"On the Disturbance of Junction-beds from Differential Shrinkage during Consolidation," by Mr. G. W. Lamplugh; "On the Igneous Rocks of Weston-super-Mare," by Mr. William Boulton; "On the Igneous Rocks of the Berwyn Mountain," by Mr. T. H. Cope and Mr. J. Lomas; "On the Recent Work of the Geological Survey," by Dr. J. J. H. Teall, F.R.S.; "Lower Ordovician Rocks in the Neighbourhood of Snowdon and Llanberis," by Mr. W. G. Fernsides; (1) "On the Origin of Certain Quartz Dykes at Foxdale, Isle of Man," (2) "On some Glacial Lakes in Switzerland," (3) "On the Geology of the Country Around Southport," by Mr. J. Lomas; "On the Porosity of Rocks," by Mr. C. C. Moore; "Notes on Sarsen Stones, with Special Reference to the Stones at Stonehenge," by Mr. H. W. Monckton; "On the Geology of Martin Mere," by Mr. H. Brodrick; (1) "On the Origin of Eruptive Rocks," (2) Observations on the Metalliferous Deposits of the South of Scotland," by Mr. J. G. Goodchild; (1) "On the Origin of the Drift Deposits of Lancashire and Cheshire," (2) "On the Striation of Boulders on Modern Beaches," (3) "Observations upon the Evidences for the Former Existence of Glacier-Lakes in N. England and S. Scotland," by Mr. P. F. Kendall. Dr. A. Smith Woodward, F.R.S., has promised a paper, but the title is not yet known. There will also be the first report of the committee appointed at Belfast to report upon the fauna and flora of the Trias of the British Isles. The greater part of this first report is furnished by Mr. Beasley, and deals with footprints.

Zoology.—There is promise of an interesting meeting in Section D. The most important event will be the open discussion on certain problems of fertilisation, in which it is anticipated that some prominent botanists will take part. Several papers dealing with the morphology of Cœlenterata have been promised, including one by Mr. Duerden on corals, and one on the physiology of digestion in Alcyonarians by Miss Edith Pratt. Mr. Crossland has promised an address on his dredging experiences in Zanzibar; Prof. McIntosh will read papers on a comparison of the terrestrial and marine fauna and on variation in Ophiocoma. Among other papers that will probably prove to be of considerable interest, there is one, by Mr. M. D. Hill, on the nuclear changes in the egg of Alcyonium. The president's address will deal partly with the question of the influence of the environment in the production of variations.

Engineering.—In this section, after the president's address on Thursday, September 10, a paper by Mr. T. Clarkson on steam driven motor-cars will be dealt with. Friday, September 11, will be mostly devoted to a discussion on the problem of modern street traffic, which will be opened by Colonel Crompton, R.E. If time permit, other papers will be taken on Friday. On Monday and Tuesday, September 14 and 15, the following papers will be discussed:—Refuse destructors, by Mr. W. F. Goodrich; natural gas in Sussex, by Mr. R. Pearson; water supply of south-west Lancashire, by Mr. T. Parry; balancing of Manchester engines, by Prof. Perry; balancing of alternators, by Mr. B. Hopkinson; gas engine explosions, by Mr. H. L. Wimperis; rainfall at Seathwaite, by Dr. Mill; and (1) cast iron used for springs; (2) alloys cast in water-cooled moulds; (3) effect of varying stresses on steel, by Captain H. R. Sankey. Several other papers will also be taken, but the final arrangements are not yet completed for these.

Anthropology.—The address of the president, Prof. J. Symington, F.R.S., will deal mainly with the significance of variations in cranial form, and will discuss the view recently revived by Prof. Schwalbe that the Neanderthal skull belongs to a distinct species of Homo, not *Homo sapiens*. It will also consider the relation between the external and internal form of the cranial wall. Among the papers accepted in physical anthropology are the following:—A study of the skulls from Round Barrows, in Yorkshire, by Dr. W. Wright; papers on skulls from the Malay Peninsula, by Mr. N. Annandale; and on the physical character of the Andamanese, by Dr. Garson; a note on Grattan's craniometrical methods, by Prof. Symington; a paper on the papillary ridges of the hand, by Dr. E. J. Evatt; another, by Mr. D. MacRitchie, on a Mongoloid type in N.W. Europe; and important reports on Dr. C. S. Myers's work on the rank and file of the Egyptian Army, on Dr. W. H. R. Rivers's researches among the Todas, and on Mr. Duckworth's investigations among the ancient and modern populations of Crete. The committee on anthropometric methods has a valuable report, and that on the teaching of anthropology will probably report *ad interim*. Archæology is unusually well represented. Mr. Arthur Evans, Mr. R. C. Bosanquet, and Mr. J. L. Myres offer reports on this year's excavations in Crete; Prof. Flinders Petrie and Mr. J. Garstang on recent work in Egypt; Mr. G. Clinch on a megalith at Coldrum, in Surrey, which illustrates certain points in Stonehenge; Mr. Annandale on stone implements from Iceland; Dr. C. S. Myers on the ruins of Kharga in the Great Oasis; Mr. T. Ashby on Roman work at Caerwent; and Mr. Garstang on Ribchester; while the usual report on Silchester excavation may be expected to lead to some discussion. Prof. R. S. Conway offers an analysis of ancient Italian place-names, as illustrating the early languages. Prof. Ridgeway has a paper on the origin of jewellery, and Mr. E. Lovett on the origin of the brooch. General ethnography (with the exception of Dr. Rivers's work on the Todas), and folklore and comparative religion (apart from Mr. W. Crooke's paper on Islam in modern India) are as yet poorly represented, but this defect will probably be made good before long.

Botany.—In the botanical section the address of the president will deal with the nature and geographical distribution of floras subsequent to the Coal period; the gradual progress of vegetation from the Lower Carboniferous period through the Coal age up to the Lower Cretaceous formations will be discussed, greater prominence being given to the Mesozoic floras. Miss Ethel Sargant will open a discussion on the evolution of the Monocotyledons, and Prof. J. B. Farmer will give a semi-popular lecture on Epiphytes. Mr. W. Bateson will give an account of the new discoveries in heredity, Miss E. R. Saunders will describe the results of some cross-breeding experiments with plants, and Mr. C. C. Hurst will describe some recent experiments on the hybridisation of orchids. Other papers will include an account of important recent advances in our knowledge of algæ, by Messrs. Tansley and Blackman; the sandhill and saltmarsh vegetation of Southport, by Dr. Otto V. Darbishire; on the seedlings of some grasses, by Miss Sargant and Miss Robertson; on willow canker, by Prof. T. Johnson; and on some experiments with the staminal hairs of Tradescantia, by Mr. Harold Wager. It is expected that a number of foreign botanists will be present at the meeting.

Educational Science.—The organising committee of this section has decided to continue the procedure adopted at previous meetings, namely, to confine the discussions to a few broad subjects. It is proposed to devote two days (September 10 and 11) to an organised discussion of school curricula, based on a series of short papers contributed by Prof. John Adams, Prof. H. E. Armstrong, F.R.S., Miss S. A. Burstall, Mr. G. F. Daniell, Mr. W. E. Fletcher, Mr. T. E. Page, Mr. J. L. Paton, and Prof. Michael E. Sadler. A joint meeting with the Geographical Section will be held to discuss the "Teaching of Geography." The discussion will be opened by Mr. H. J. Mackinder, and he will be followed by several gentlemen who have devoted special attention to this important branch of school work. In addition to these subjects, there will also be discussions on the reports of committees on:—(*a*) "The Conditions of Health Essential to the Carrying on of the Work of Instruction in Schools"; (*b*) "The Teaching of Natural Science in Elementary Schools"; (*c*) "The Influence Exercised by Universities and Examining Bodies on Secondary School Curricula, and also of the Schools on University Requirements"; (*d*) "The Teaching of Botany in Schools."

NATIVES AND CUSTOMS OF CHUTIA NAGPORE.[1]

THIS bright and picturesque book, which should be widely read, gives in its text and illustrations a vivid picture of the eastern side of Chota, called by the natives Chutia Nagpore, the motherland (Chut) of the Nagas, who were Naga-Kushikas, sons of the Naga Cobra and the tortoise. But I hope that its interesting description of the country, its inhabitants and their festivals, and its glimpses into the traditional history of the past, especially those given in chap. v. of the Santal birth legends, are only a prelude to works

[1] "Chota Nagpore: a little known Province of the Empire." By F. B. Bradley Birt. Pp. xiv+310. (London: Smith, Elder and Co., 1903.) Price 12s. 6d. net.

of deeper research, in which the present author and others living in Chutia Nagpore may try to disentomb from below the present surface the ancient history of the country which was once the treasury of the Naga rulers of India, and will undoubtedly be in the future its richest manufacturing province. It contains about 5000 square miles of coal-fields, only worked on its eastern rim, inexhaustible supplies of iron ore, red and brown hæmatite, magnetite and limestone, immense wealth in other minerals, and in the remote past the gold of its gold-bearing river-sands and its diamonds filled the coffers of the Naga-Kushika kings. The central mountain of their realm was Parisnath, described in chap. vi., which was first the Marang Buru or Great Mother Hill of the Mundas and Santals. The Kushikas called it Mandara, the revolving mountain, and it was finally consecrated as the sacred mountain in the east of the trading Jains of the west, who gave it its present name of the Lord (nath) of Traders (Pañris).

The history of the country told in the legends, ritual and customs of its numerous tribes, takes us back through layer after layer of deposit beneath the surface of to-day to the first age of Indian village life surviving in Jushpore and Sirgoojya among the Korwas, who are nomad agriculturists living in rude huts of tree branches in forest encampments, vacated every two or three years. Their women add to the tribal food they collect in the woods and the animals killed by the men of the tribe, the produce of the crops they sow in their clearing until the soil is exhausted. Their successors were the Mundas and Marya or tree (marom) Gonds, living in permanent villages under the shade of the Sarna or village grove of old forest trees left standing in the ring of cleared rice land, the Gond tribal sacred snake. Beside the Sarna is the Akhra or dancing-ground, well depicted in the illustration here reproduced of Girls and Musicians at a Santal dance (p. 128). There the seasonal dances are held, a separate step and figure being set apart for each season, and thither in the primitive age the women of each village invited to these dances the men of one adjoining it in the same province or Parha, and there the children of each village were begotten as the offspring of the mother trees of the sacred grove. Their Spartan education, in separate establishments for each sex, by the women and men of each village to whom their mothers were sisters, still exists among the Ooraons of Chutia Nagpore, the Nagas of Assam, the islanders of Melanesia in the Indian Archipelago, and other races. They were taught to repeat the national educational and historical stories, and made thorough proficients in all their tribal duties.

We can trace in Chutia Nagpore the stages of advance from the simple primitive villages of the Mundas and Marvas to the elaborate Ooraon villages with allotments for village servants, in which the lands are divided into Manjhus or Lord's land, the Bhuinhiari land of privileged tenants eligible as Headman, Pahn or Village Priest, and Mahto or Accountant and the land of ordinary tenants, whose duty it is to till the landlord's Manjhus land. We can further study local history in the ritual customs and traditions of the laughter-loving and indomitably independent Mundas and Ho Kols, the Irish of India, of the silent and dogged Bhuyas, the musical Ooraons, forming a mixture of these two types, in the farming skill of the Kaurs and the feudal customs of the Chiroos and Kharwars, the ancestral rulers of Magadha, who attached Chutia Nagpore to their confederacy and ended the chain of aboriginal rulers, in which Mundas, Bhuyas, Gonds, Ooraons, and Kaurs were the successive links.

FIG. 1.—Girls and Musicians at a Santal Dance.

The three last, Ooraons, Kaurs, and Chiroo-Kharwars, were the sons of the barley as their predecessors were sons of the rice. Their national birthday is the

July-August festival of the Kurum, when they dance round the national mother, the kurum almond tree (*Nauclea Parvifolia*), wearing barley shoots in their hair, and the festival corresponds to the Hindu Nag Punchami, the five mother snakes held in the same month. The union of the rice-eating sons of the south with the northern eaters of barley is marked by the Magh festivals of January-February (p. 102) in Chutia Nagpore, and the Magh festival of Puryag at the junction of the Jumna and Ganges, where the union with the men of the south of the Kushika Gonds, who came down the Jumna, is celebrated by the offering as sacrifices of living victims brought in by the northern people as additions to the southern ritual, in which the only sacrifices had been the first fruits of the soil offered by the primitive villagers, and the fowls slain by the Munda sun worshippers.

It was the castes who form the northern stratum of the community who began the custom of wedding brides and bridegrooms to mahua and mango trees, while almost all castes still retain the leafy marriage bower in which weddings are celebrated as a reminiscence of their ancestors, who were sons of the tree before the northern growers of oil-seeds, barley, and other crops of Asia Minor substituted individual marriages for village unions.

The last stage in primitive national history is that of the race of the trading Jains of the Bronze age, and its length is marked by the vast excavations they have made in the copper hills of Lando in Seraikela and Baragunda, under Parisnath. They formed the port of Tamluk, called Tamra-lipti or Copper-port, and have left lasting memorials of their rule in the ruins of their capital at Dalmix on the Subanrikha, their temples at Telkupi (p. 177), and along the ancient road to Orissa, and in the establishment of the brass-ware industry of Manbhum, which supplied the brass vessels looked on as sacred in modern Hindu domestic ritual.

J. F. HEWITT.

THE SEISMOLOGICAL CONGRESS IN STRASSBURG.

IN July of last year the British Government received an official invitation from Germany to take part in a conference the object of which was to establish an international inquiry about earthquakes. The meetings of this conference, which took place in Strassburg—July 23 to 28—usually commenced at 9 or 10 a.m., and concluded at about 5 or 6 in the afternoon. The proceedings were reported at length in the *Strassburger Korrespondenz* and other papers.

At the opening ceremony the chair was occupied by His Highness Prince Hohenlohe-Langenburg, his supporters being representatives of the Imperial Government and other officials. Twenty-five States or countries were represented, but the total number of delegates and guests who were at liberty to take part in the proceedings up to the time when final votes were demanded seems to have been exactly one hundred. As sixty-two of these were Germans, it can be easily imagined that German language and German influence preponderated in debates, and although ultimate results were arrived at by the single voices of separate countries, when Great Britain and her colonies, like the German Empire, had each one vote only, it is difficult to suppose that these results are entirely free from German bias.

France was not officially represented. When we consider the powerful influence exercised by this country upon the progress of science, the impetus given to seismology by Perrey, Montessus and other workers, together with the desirability of establishing stations in French colonies, a feeling of regret arises that so important a State was unable to assist the congress. Whether this would have been the case had the same been held in some other town than Strassburg is a matter for conjecture. The chief results arrived at were as follows:—

A central association is to be formed with its headquarters in Strassburg. Each contributing country will be represented by one member on a governing committee which elects a president, a chief for the central office, and a general secretary. The chief will reside in Strassburg, but it was decided that the president and secretary should be elected from outside Germany. Although it is desirable that these officers should represent different nationalities, it is also desirable that the chief of the central office and his secretary should reside at the central office.

It was suggested that the work of the association should be as follows:—

(1) To make observations after a common plan approved by the association. Inasmuch as there now exists in connection with the British Association, in Italy, in Japan, and in other countries established systems for seismic observations, which on account of the expenditure it would involve and for other reasons could not be reduced to a common plan, and further, that as direction from a centre would destroy incentive to investigation, this proposition was abandoned.

(2) To carry out experiments on important matters.

(3) To establish and support observatories.

(4) To collect, study, and publish reports or *résumés* of the same.

The detailed investigations referred to in the second suggestion are not unlike headings for chapters in a treatise on seismology. This work, and that embodied in the third and fourth proposals, are for the first twelve years to be carried out at a cost of 1000*l.* per annum, and this sum is to include a salary for the general secretary. The contributions to this inadequate sum are to be apportioned amongst the cooperating States according to population, the British contribution to be 160*l.* per year. Whether the British and other Governments will take part in the scheme remains to be seen. Assuming that they do, inasmuch as 1000*l.* per year is far too small an amount to meet expenses connected with the proposed programme, it seems likely that the central office at Strassburg, in its early days at least, will become a depôt from which reports are issued and a distributing centre for earthquake registers and other materials bearing upon recent seismological research. This in itself is a work of a magnitude not generally realised, a mere catalogue of earthquakes which have been recorded during ten years in Japan, for example, making in itself a volume of 1000 pages. To reduce publications of this description, written in Chinese characters, to a form in which European investigators might wish to see them would be a labour which but few would undertake. Yet Germany offers men who are willing to face such labours, whilst her Imperial Government asks the civilised world to cooperate in carrying out the gigantic task. Now at the eleventh hour, in the name of science and because other nations are apparently unprepared or indifferent to the advantages of centralisation, it seems likely that the seismological work of all countries is to be swept into one great net.

Germany has but few observing stations and no organised system for seismological investigations of her own, yet she is willing to take beneath her ægis the organisations of the world. Whether it be in the relief of a beleaguered city or in the study of an obscure science, Germany desires to take the lead. To turn the eyes of the world towards Berlin as the centre of

all learning turns the steps of students in the same direction, and a Government which fosters such a policy is deserving of its country. Germany has offered to take upon her shoulders a burden which others shirk, and if this can be achieved to the satisfaction of those concerned, she deserves great praise.

While this no doubt is one view of the situation, it must not be overlooked that Governments, particularly those that do not feel justified in giving support to seismological investigation within their own territory, may hesitate in offering support to such investigation in a foreign State. To suggest that a powerful empire needed 1000*l.* a year to carry on the proposed work would be wanting in good taste. Neither can it be suggested that delegates at the conference have carried away with them the impression that they are to receive something greater than a *quid pro quo.* Should the proposed convention be ratified, what they may possibly discover is that a birthright has been exchanged for a mess of pottage, and for a period of twelve long years a suzerainty has to be acknowledged. Truly enough the movement is called international, but at the same time it bears the character of absorption and crystallisation at a centre, and it is not every country that will care to add to its neighbour's prestige at the expense of its own, play second fiddle, and pay for the privilege. That seismology will benefit by cooperation there is but little doubt, but whether Germany can carry out what has been proposed, and whether the scheme has been presented in its best form are matters open to discussion.

NOTES.

WE are informed that Mr. A. S. le Souef has been appointed director of the zoological garden at Sydney in succession to the late Mr. Catlett. Mr. Dudley le Souef, his elder brother, has been director of the gardens of the Zoological and Acclimatisation Society at Melbourne for several years, and a younger brother is director of the newly established garden at Perth, in Western Australia, so that the three brothers occupy three corresponding positions in the three Australian capitals.

FOR the study of bird migration, Mr. W. Eagle Clarke, assistant keeper in the Natural History Department of the Edinburgh Museum of Science and Art, has obtained permission from the Elder Brethren of Trinity House to spend a month upon the Kentish Knock Lightship, situated off the mouth of the Thames, and about twenty-one miles from the nearest point of land. The position of the vessel affords exceptional opportunities for observing the east to west autumnal movements of birds across the southern waters of the North Sea.

THE meeting this year of the French Association for the Advancement of Science was held at Angers under the presidency of M. Émile Levasseur, who, in his presidential address, dealt with one of those economic questions around which, at the present time, many controversies are being raised. "Wages," said M. Levasseur, "have furnished the material for hundreds of volumes and millions of fugitive leaflets which daily discuss the subject in all civilised countries," and he went on to devote his address to a consideration of three main questions affecting the wage-earner. These may be stated in the following words. "What causes determine the rate of wages?" "Have wages increased?" "Is the wage-earner a permanent factor in the organisation of labour?" In discussing the first question, the president recognised a number of causes for the variations in the rate of wages; among these factors are the productivity of the worker, the cost of living for the workman and his family, the general prosperity of the country, the special abundance of capital in each industry, the opposition between workers and employers, and political institutions and customs. After examining his second question, M. Levasseur concluded that wages have risen in France and in other civilised countries, and that the cause of it is the growth of riches, the progress of industry, the development of machinery, and the greater individual and collective value of the worker. The grants for scientific research made by the association amount this year to about 760*l.*, and this sum was divided among some fifty recipients, including certain scientific associations as well as men of science.

A REUTER telegram from Buenos Ayres states that severe shocks of earthquake were felt on August 12 at Mendoza. A number of houses and the tower of a church were destroyed.

VESUVIUS is in a state of active eruption. The Rome correspondent of the *Daily Chronicle* says a stream of boiling lava is flowing in a north-easterly direction towards San Giuseppe and the village of Ottajano, and has already reached a length of 800 metres.

A SEVERE hurricane passed over the island of Jamaica during the night of August 10–11, causing serious damage and loss of life. On August 8 the U.S. Weather Bureau notified its local agent at Kingston that a disturbance north-east of Barbados was moving to the north-west over the Windward Islands, and would probably develop a dangerous strength. Little notice, however, was taken of the warning. The storm was most severe in the early morning hours of August 11, and the whole of the eastern and north-eastern half of Jamaica has been desolated by it.

THE preliminary international conference on wireless telegraphy came to an end on August 13. The results of the conference have been embodied in draft regulations for the control of wireless telegraphy which it is proposed to submit to the various Governments concerned. A further conference may then be summoned to enter into an international convention based on these regulations; it is said that Germany intends before long to invite the European sea Powers and the United States to take part in a more general conference with this object. The conclusions at which the delegates at the preliminary conference arrived have not yet been made public.

AN instance of the practical advantages of wireless telegraphy at sea was given by the *Observer* last Sunday. A gentleman crossing to New York by the *Campania* discovered in the middle of the voyage that he had not sufficient money to pay his customs dues on arrival, nor did he know anyone on board from whom to borrow. He remembered, however, that his mother was crossing from New York by the *Lucania*, and the two vessels having got into communication by wireless telegraphy, he transmitted a request to her to pay the purser 10*l.*, asking him to advise the purser of the *Campania* to pay the sum to him. The transaction was successfully accomplished within an hour; it seems that with the spread of wireless telegraphy on ships, all the business that we are accustomed to transact on land will be able to be carried on with equal facility at sea.

AN account of some further experiments on the heat radiating power of radium, carried out by M. Curie in conjunction with Prof. Dewar at the Royal Institution at the time of M. Curie's lecture last June, is given in the *Times* of August 13. The facilities for accurate research at low

temperature which Prof. Dewar has developed at the Royal Institution laboratories enabled some careful experiments to be made. It was found that the heat radiating power of radium bromide is not diminished at the temperature of liquid air, and is actually greater at the temperature of liquid hydrogen. It is stated that the experiments leave no room for doubt that the rate of emission of heat by radium is greater at the temperature of liquid hydrogen than at any temperature from that of liquid air up to that of an ordinary room. The experiments also showed that the radiating power of a salt, or solution of a salt, of radium increases for about a month after its preparation to a maximum at which it then apparently remains stationary.

THE fire which occurred last week on the Paris Metropolitan Railway is probably the most disastrous which has taken place in connection with electric traction. In addition to the sympathy one feels for the unfortunate victims and their relatives, the accident is to be especially regretted as tending to discredit a system of transit which was becoming increasingly popular in this country. But although the fire was apparently started by the fusing of an electric wire, the terrible results which followed can in no way be charged to the account of electric traction, nor indeed to the system of underground railways. So far as one can judge by what is as yet known, there seem to have been serious mistakes made after the fire had been first noticed, and finally a panic resulted with its attendant dangers. But for this the accident might have been followed by little serious result; it is safe to say that in all accidents of this kind the best that any system can do is to safeguard, as far as possible, against the occurrence of a panic, for once this occurs the result is in no way commensurable with the original accident, and whatever precautions for safety may exist they are rendered inoperative.

THE Antarctic relief ship *Terra Nova* will leave Dundee on August 21. The vessel will proceed to Hobart, where she will be joined by the *Morning*. Captain McKay will command the *Terra Nova* and Captain Colbeck the *Morning*. Each vessel will carry instructions in duplicate for Captain Scott, upon whom the supreme command will devolve when communication has been established. A *Globe* correspondent states that the French Antarctic Expedition has sailed from Havre under the leadership of Dr. Charcot. The first task to be undertaken by the expedition will be that of finding the Swedish Antarctic Expedition under Nordenskjöld, which, it is supposed, is fast in the ice off Graham's Land. If Nordenskjöld should be found, then a voyage will be made into the Antarctic Ocean, mainly for purposes of scientific research, as the expedition will not try to establish an "Antarctic record." Dr. Charcot is taking out five men of science, and provisions for twenty-eight months, as the expedition will be absent nearly two years. A Reuter message from Stockholm reports that the Swedish expedition for the relief of Dr. Otto Nordenskjöld's South Polar Expedition sailed from there on August 17 on board the *Frithjof*.

THE recent serious floods in Silesia have raised an interesting point as to the relation between them and deforestation. The rivers which inundated Silesia have their origin in Austria, and it appears from a Berlin message in Monday's *Morning Post* that the Prussian authorities are informed by experts that the overflows are due principally to the deforestation of the Austrian highlands, which have become so barren of timber that the rivers no longer lose the large quantity of water which the trees formerly absorbed. Prussia has concluded, therefore, that until the Austrian highlands are retimbered the flood danger in Silesia cannot be eradicated, and heavy relief expenditure, such as the 500,000*l*. just granted, will be wasted.

WE learn from *Science* that it is proposed to celebrate the seventieth birthday of Prof. August Weismann, which will occur on January 17, 1904. The committee has decided to have prepared for that time a portrait bust of Prof. Weismann, which shall be deposited at the Zoological Institute of the University of Freiburg with appropriate festivities. It invites cooperation in this undertaking, not only from those who owe scientific stimulus to Prof. Weismann and have been guided by him into zoological activity, but also from all colleagues who desire to join in honouring Prof. Weismann for his work. Contributions may be sent to the Deutsche Bank, Leipzig, for the account of Prof. Zur Strassen, who is treasurer.

THE first International Exhibition of Industrial Art for Metal or Stone Products will be held at St. Petersburg in November next. The exhibition has the object of making the public acquainted with the progress attained by Russian and foreign industry in the artistic finish of metal and stone products.

THE Liverpool School of Tropical Medicine has decided, with the cooperation of the Government of the Congo Free State, to dispatch a trypanosoma expedition to the Congo Free State in September. The objects of the expedition will be to report on the sanitary conditions of Boma, Leopoldville, and other centres visited, and to recommend improvements of existing sanitary conditions; to continue the work of trypanosomiasis, human and animal, including the occurrence and distribution of trypanosoma in the Congo, the carriers of the parasite, and the relation of trypanosoma to sleeping sickness. Major Ross, of the Liverpool School, has received a letter from Major Penton, the principal medical officer of the Sudan, testifying to the success of the measures taken against mosquitoes for the prevention of malaria. Ismailia has been found by Major Penton to be practically free from mosquitoes, and to show a striking improvement as regards malarial fever.

THE committee of the National Physical Laboratory announces that it is prepared to test the accuracy of the pipettes, measuring glasses, and test-bottles used in the Lister-Gerber and other methods of testing milk. The fees charged are very moderate, and in view of the increasing attention that is being bestowed upon our milk supplies, these facilities should be largely made use of.

IN addition to the usual circulars respecting the close seasons for the salmon and other fisheries, the Fishmongers' Company has issued a notice with regard to the opening of the oyster season. It is pointed out that the various oyster beds, pits and layings round the coasts have been inspected, and all those proved to be polluted with sewage have been closed, and no oysters from these places will knowingly be allowed to be sold until they have been proved to be safe and wholesome. The coöperation of the medical and sanitary authorities in this matter is invited.

THE July number of the *Journal of Hygiene* (No. 3, vol. iii.) contains several papers of considerable interest. Drs. Newsholme and Stevenson describe the graphic method of constructing a "life table," and Mr. Hayward gives a new "life table" for England. Dr. Meredith Richards discusses the factors which determine the incidence of infantile diarrhœa, and concludes that artificial feeding and in-

sanitary milk supply are the most important. Dr. Fremlin describes the cultivation of the nitroso-bacterium, and Dr. Durham a new diluting pipette. Dr. Haldane finds that the presence of sulphur in coal-gas is the principal factor in vitiating the air, and Dr. Savage has investigated the relation between the pathogenicity of *bacillus coli* in drinking water and purity. Dr. Graham-Smith describes further researches upon factors which may modify the biological or precipitin test for blood.

DR. ROBERTO BOROLA, of Pavia, contributes to the Lombardy *Rendiconti*, xxxvi. 12, a note on the metric properties of quadric surfaces in non-Euclidean geometry, dealing with circular sections, foci, and confocal and concyclic systems of quadrics.

AN interesting extension of the use of Green's functions to the mathematical theory of conduction of heat is given by Prof. H. S. Carslaw, of Sydney, in the *Proceedings* of the Edinburgh Mathematical Society, xxi. The use of Green's functions has hitherto been mainly confined to the theory of the potential, although their use in connection with heat conduction has been mentioned by Minnigerode and Betti. Prof. Carslaw now shows how the functions in question can be obtained by means of contour integrals, and a general method applied to the solution of problems which are usually solved by independent methods.

"RED RAIN" forms the subject of a paper by Messrs. F. Chapman and H. J. Grayson in the *Victorian Naturalist* for June. The occurrence of dust-laden showers is not infrequent in Australia, but one of the most remarkable showers of this kind occurred on February 14 of this year. The writers describe analyses of samples of sediment collected from this shower at Camberwell and St. Kilda, and they compare the substances observed with the minerals contained in the dust commonly present on the roof of the National Museum, Melbourne. A sample collected in a second shower of "red rain" at St. Kilda on March 28 was also examined. The latter sediment was remarkable for the number of diatoms it contained, and the authors enumerate a list of the forms found, including about twenty-five species.

THE coefficient of thermal surface-conductivity across the surface of separation of a solid and a fluid is a quantity the determination of which is of considerable importance, especially in connection with the construction of boilers. In the *Zeitschrift* of the German Engineers' Association, Mr. L. Austin describes experiments made at Charlottenburg on this subject, giving the following results:—From metal to water at the boiling point the resistance is equivalent to a thickness of 1·2 to 2cm. of iron, but is reduced by stirring by an amount equivalent to about 0·75cm. of iron. The resistance increases as the temperature falls, reaching a maximum of 10cm. of iron, which is reduced by 1cm. by stirring. For flow of heat from water to metal, the resistance appears greater than for the reverse flow if the water is undisturbed, and about the same when the water is stirred.

THE *Atti dei Lincei*, xii. 10, contains a brief account of experiments in syntonic wireless telegraphy carried out at Spezia under the direction of the Minister of Marine. At San Vito two Marconi apparatus of frequencies "A" and "B" were connected with the same antenna, and communication was carried on simultaneously with Palmaria and Leghorn at distances of respectively 5 and 70 kilometres.

IN the *Atti dei Lincei*, xii. 11, Prof. G. Agamennone directs attention to an interesting contribution to our knowledge of terrestrial magnetism in the form of a discourse by Father Francesco Eschinardi, published in 1681, in which he makes mention of a sudden change in the magnetic declination at Rome from about 3° to 5° W., which occurred towards the end of October of the previous year. This the writer attributed to the effect of earthquakes in Spain and Malaga.

THE annual list of new garden plants of the year 1902, which is issued as an appendix to the Kew *Bulletin*, has been received.

A RECORD of plants collected in the northern region of Yucatan is commenced in the *Publications* of the Field Columbian Museum. The first fascicle, which treats of the ferns included in the Polypodiaceæ and Schizæaceæ, and the monocotyledonous orders Gramineæ and Cyperaceæ, is the joint work of Mr. C. F. Millspaugh and Miss Chase.

THE question of shade for coffee and cocoa plants is discussed in the Jamaica *Bulletin* of the Department of Agriculture, where it is pointed out that in many cases it is the bacteria working in the soil, and not the plants which require the shade. The choice of leguminous plants for the purpose is a wise one, as the nitrogenous contents of the soil are thereby increased. An article by Mr. Cousins, contrasting the constituents of four definite phosphatic fertilisers, serves to point the absurdity of an indiscriminate application of commercial fertilisers without taking into consideration the nature of the soil.

WHATEVER may be the outcome of the present political question of fiscal reciprocity towards our colonies, there can be no doubt about the advantages of a closer connection between them and the mother country. To further this object a scientific and technical department of the Imperial Institute was established, and a laboratory was provided wherein samples of raw material from the colonies can be analysed and reported upon by experts, as has long been done for vegetable products at Kew. In the second number of the *Bulletin* of the Imperial Institute, there appears an account of recent investigations undertaken by Dr. Dunstan and his assistants. These include the examination of rubbers from Africa, oil shale from Natal, iron ore from a district in the Bombay presidency, and other products. Also there are added special notices on various industries which are receiving attention in our dependencies and those of other European States.

IN vol. ii. of *Marine Investigations in South Africa* Mr. R. Kirkpatrick, of the Natural History Museum, continues his descriptions of the sponges, naming some new genera and species.

THE nature of the so-called terminal buds of fishes—organs scattered over the skin of the head in certain teleosts and ganoids, and at one time regarded as tactile in function—forms the subject of an article by Mr. C. J. Herrick, published in vol. xii. of the *Journal of Comparative Neurology*. It is inferred that these structures have no connection with the lateral line system, but are intimately related to the taste-buds of the mouth.

THE July issue of the *Emu* contains a number of interesting articles devoted wholly, or chiefly, to ornithology. In treating of New Zealand cormorants, Captain F. W. Hutton suggests that one group of these birds reached New Zealand from South America, and that, after considerable modification in the Antipodes, their descendants returned to their ancestral home, whence some found

their way to Kerguelen Island. This, it is argued, indicates that islands were formerly more numerous in the Antarctic than at present. Among the illustrations in the number before us, one plate shows a native high up in a gum-tree taking the nest of the white-tailed cockatoo, and a second the countless swarms of sooty terns which haunt the Great Barrier Reef in the breeding season.

IN an article entitled "The Genesis of the Kangaroo," a correspondent of the *Newcastle Daily Journal* of August 4 seeks to obtain credence for a view, current among Australian settlers, as to the early stages of development in these animals. Briefly stated, this view is to the effect that "after impregnation, the mingled germs find their way from the womb, or receptacle answering to such, through a duct or channel straight to the point of the teats," and that consequently the whole of the development takes place while the embryo is attached to the summit of the nipple. Nothing is said with regard to the position of the mysterious duct or channel alluded to in the quotation, while the commonly accepted view, namely, that the mother transfers the embryo from the vagina to the nipple, is dismissed with the statement that this is not supported by direct observation. Apparently the author is unacquainted with a note published some years ago in the *Zoologist* (and referred to in our columns at that time), in which Mr. D. le Souëf describes this transference in considerable detail, and states that it is effected solely by the maternal lips.

THE report of the British Museum for the year ending on March 31 last has been published as a Blue-book. In the natural history section the director records an increase in the number of visitors, and likewise in the list of donations. Attention is directed to the completion of the Nile Fish Survey, and to Dr. Andrews's geological explorations in Egypt, funds for which have been generously provided by Mr. W. E. de Winton. It is satisfactory to learn that the whole of the collections to be made by the National Antarctic Expedition are to come to the museum, and that the trustees have agreed to publish an account of the natural history results of the voyage. As regards the new section of economic zoology, a summary is given of work accomplished in advising the Board of Agriculture in regard to insect ravages and kindred subjects, and of visits paid in connection with the Board. A long list of correspondence in connection with mosquitoes and malaria indicates the energy with which these investigations are being pushed. Some progress has been made with the exhibition of economic zoology in the north hall, and collections of insects affecting economic products have been received from various parts of the world.

DR. HENRY HOEK, of Davos, has issued separate copies of a detailed paper on the geological structure of the central "Plessurgebirge" in the neighbourhood of Arosa (*Berichte der Naturforschenden Gesellschaft zu Freiburg-im-Breisgau*). Inspired by Prof. G. Steinmann, the author has sought to work out in detail the complex features of the district, which is well known in its general aspect to visitors to the Engadine. In so doing, he gives considerable credit to the observations of the English geologist, the late Mr. A. V. Jennings. The overfolding and repetition of strata by thrust-faults are well shown in numerous sketches and diagrams, and plate xiv. gives us a broad landscape, with the geology marked out on it in the clear and effective manner of Murchison and the early authors. Dr. Hoek concludes by supporting the views of Steinmann and Jennings in opposition to those of Rothpletz and Lugeons, and affirms that the main range, including the Brüggerhorn and the Hörnli, is a mountain-mass of eastern Alpine type, pushed up from the south-east over a "Vorland" of Flysch. This Flysch, it is argued with reason, is entirely of Cainozoic age, and the mass of older rocks has been pushed across it for a distance of some 4 kilometres.

PROF. L. PLATE's memoir "Über die Bedeutung des Darwin'schen Selectionsprincips," which was reviewed in NATURE of May 16, 1901 (vol. lxiv. p. 49), has reached a second edition. The new edition contains nearly one hundred pages more than were included in the original work, and the words "und Probleme der Artbildung" have been added to the title.

THE sixth edition of Prof. R. Hertwig's "Lehrbuch der Zoologie" has been published by Herr Gustav Fischer, Jena. The work originally appeared in 1891, and was favourably noticed in these columns (vol. xlviii. p. 173). The present edition has been enriched with many new illustrations, and the text has been revised in the light of recent theory and investigation in zoological science.

TWO useful volumes have been published by the Treasury Department of the United States Coast and Geodetic Survey. One is a list and catalogue of the publications issued by the survey from 1816–1902, and has been compiled by Mr. E. L. Burchard; the other is a second edition of a bibliography of geodesy, by Prof. J. H. Gore. This bibliography has been carefully revised to 1902, and deals with all books and papers on the subject in every language.

THE "List of Publications of the Smithsonian Institution, 1846–1903," by Mr. William J. Rhees, a copy of which has been received from the institution at Washington, will prove of great assistance to all readers who have access to the volumes indexed. The "list" consists of two parts; the first is a complete list of Smithsonian publications in numerical order, which is also approximately chronological; the second part contains a list of publications, available for distribution, arranged under subjects and authors. In this list are included the papers and addresses by eminent men of science which have appeared in the appendices to the annual reports of the Smithsonian Institution.

THE extension section of the Manchester Microscopical Society has issued a revised list of fifty-four lectures arranged for delivery by its members during the coming winter. The work of lecturing is voluntary and gratuitous on the part of the members, but hire of slides, travelling, and out-of-pocket expenses are charged. The purpose of the lectures is to bring scientific knowledge, in a popular form, before societies unable to pay large fees to professional lecturers, but in all cases where lectures are given before societies which are commercial undertakings, or are subsidised by grants, a fee is charged. The subjects of the lectures are varied and well chosen, and this pioneer work of the Manchester scientific workers deserves wide appreciation.

WE have received a reprint of an article, from vol. ix. of the decennial publications of the University of Chicago, on "New Instruments of Precision from the Ryerson Laboratory," by Mr. R. A. Millikau. The instruments described are a substitute for Atwood's machine, a Young's modulus apparatus, a "moment of inertia" machine, and a vapour-tension device. The pieces of apparatus are ingenious and likely to prove useful in the teaching of practical physics, but two at least can hardly be described as new. The substitute for Atwood's machine is merely a slightly modified form of the familiar smoked glass plate

falling in front of a vibrating tuning fork to which a suitable style is attached. It may interest Mr. Millikau to know that this device has been used by students at the London Royal College of Science for the last twenty years. Similarly the vapour-tension device is an improved form of the bent tube with the shorter limb closed and with mercury in the bend which has long been used in laboratories in this country for the determination of boiling points.

THE additions to the Zoological Society's Gardens during the past week include an Anubis Baboon (*Papio anubis*) from West Africa, presented by Mrs. J. B. Ward; a White-crowned Mangabey (*Cercocebus oethiops*) from West Africa, presented by Mrs. Stevenson; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. F. W. A. Jackson, R.A.; a Black Rat (*Mus rattus*), British, presented by Mr. Oswald M. Courage; six English Vipers (*Vipera berus*) from Dorset, presented by Mr. A. Old; two Slender Loris (*Loris gracilis*) from Ceylon, a Black Hornbill (*Sphagolobus atratus*) from West Africa, three Westerman's Eclectus (*Eclectus westermani*) from Moluccas, ten Common Skinks (*Scincus officinalis*) from North Africa, deposited; a New Zealand Parrakeet (*Cyanorhamphus novae-zealandiae*), a Golden-headed Parrakeet (*Cyanorhamphus auriceps*) from New Zealand, purchased; a Garnett's Galago (*Galago garnetti*) from East Africa, a Stanley Crane (*Anthropoides paradisea*) from South Africa, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF COMET 1903 *c*.—On July 14 and 15 Dr. Curtis, of the Lick Observatory, found that the visual spectrum of this comet consisted of a strong continuous spectrum, and the three characteristic cometary bands, that at λ 4770 being by far the brightest. He tried to photograph the spectrum by giving a six hours' exposure with the 36-inch telescope, but obtained no result, the intrinsic brightness of the comet being too small.

Prof. Perrine, using a small slit spectroscope with the Crossley reflector, obtained a spectrum with four hours' exposure, and found that it contained the five bands obtained by Campbell in Comet *b* 1893 (Rordame) and in Comet *b* 1894 (Gale), viz. 388, 409, 421, 436 and 473. The bands obtained by Perrine also agree in brightness with those previously photographed, with the exception of that at λ 420, which was one of the brightest bands in the former comets, but is very weak in this one (Lick Observatory *Bulletin*, No. 47).

THE SPECTROSCOPIC BINARY β SCORPII.—Working with the new spectrograph of the Lowell Observatory, Mr. V. M. Slipher has determined that the spectroscopic binary β Scorpii has a very wide range of velocity, extending over 250km. from −109km. to +146; these variations are satisfied by a period of 6d. 21h.

The spectrum of each of the components is of the Orion type, and the velocity determinations were made from measurements of the lines Hγ, λ 4388, and λ 4472 (Lowell Observatory *Bulletin*, No. 1).

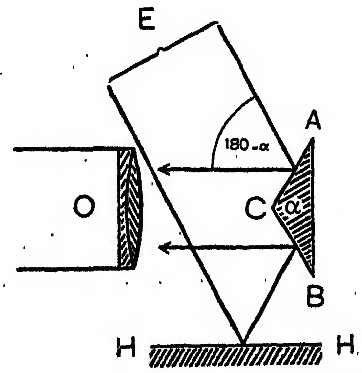
EFFECTS OF ABSORPTION ON THE RESOLVING POWER OF SPECTROSCOPES.—In a mathematical discussion of the manner in which the absorption of a train of prisms affects the resolving power of a spectroscope, Prof. Wadsworth, of the Allegheny Observatory, has found that for small absorption values the actual resolving power is practically identical with its theoretical value, but as the absorption increases a most important diminution of the resolving power takes place. So rapid is this diminution that in several actual instruments now in use, which were designed to give great resolution, this end has been defeated by the high absorptive power of the dense flint prisms used in their prism-trains. Thus in the Young spectroscope, the theoretical resolving power in the neighbourhood of the H and K lines is 300,000, whilst the practical power is only about 57,000, actually less than that which an instrument one-fourth the size would possess.

Prof. Wadsworth summarises the results of his discussion in the following statements. "It is at once evident from these results that if high-power prism spectroscopes are to be used in the investigation of the photographic region of the spectrum, the use of extra dense flint glass, so commonly employed in the past, must be avoided, not only on the score of light-efficiency, but, as now appears, on the score of photographic resolving power and purity as well. The use of lighter flint reduces the theoretical resolving power of any given prism train by decreasing the value of the dispersion coefficient, but this may be easily, and even advantageously, compensated by increasing the refracting angle of the prisms."

Many new spectroscopes have been designed on the principle enunciated above, amongst others those of the Allegheny, Lowell, and Philadelphia Observatories may be mentioned (Miscellaneous *Scientific Papers* of the Allegheny Observatory, No. 11).

A NEW CIRCUMZENITHAL APPARATUS.—A novel apparatus for determining zenith distances has been devised by Fr. Nušl and M. J. J. Frič, of Prague, and is described and illustrated in a *Bulletin International de l'Académie des Sciences de Bohême*.

The accompanying diagram shows the essential features of the apparatus. When the star E approaches the altitude 180-α it forms, at the focus of the telescope O, two images, one of which has been reflected directly from the face AC of the prism ACB, the other from the face CB after reflection from the surface of a bath of mercury HH; these two images coalesce at the moment that the star crosses the zenith circle at altitude 180-α, and that moment is chronographically recorded.



Numerous improvements have been made on the original design, the chief of which consists in substituting two mirrors inclined to each other at the angle α in place of the prism shown here, and, by inserting small prisms, the star images are observed as sharply defined horizontal lines. Using a telescope of 350mm. focal length and 40mm. aperture, with a 50 eye-piece, a determination of time correct to ±0·05s.—0·06s. may be made, and by observations of three stars a determination of latitude correct to ±0″·22 is easily performed.

THE SECCHI COMMEMORATION.—The twenty-fifth anniversary of the death of Padre Angelo Secchi was commemorated at the Collegio Romano last spring, when an address was read by Prof. Elia Millosevich. This has since been published, with a portrait of Secchi, by the Press of the Lincei Academy.

THE NEW YORK ZOOLOGICAL SOCIETY.[1]

ALTHOUGH the preservation of the native animals of the United States is one of the avowed objects of the New York Zoological Society, the establishment of small parks, where the larger species can live and multiply under conditions approximating as nearly as may be to their natural surroundings, has been specially undertaken by the sister society at Washington. And, so far as we gather from the report before us, the authorities at New York are directing their attention to the exhibition of animals from all parts of the world on an equal footing. Considering that the year (1902) to which the report relates is only the fourth

1 "Seventh Annual Report of the New York Zoological Society." Pp. 205; illustrated. (New York, 1903.)

in the development of the Zoological Park and of the serious work of the society, all concerned are to be heartily congratulated on the progress that has been made up to date, and the promise of rapid advance in the near future. A gratifying feature in the year's record was the transference of the New York Aquarium to the management of the society, since, as we are told in the report, this was made spontaneously by the municipality without any suggestion on the part of the governing body. The society has organised the administration of the aquarium on practically the same basis which has been found so effective in the case of the Zoological Park, with a director and council who secure the best expert advice obtainable. As regards the general progress of the park, the report records the completion of a lion house, and the issue of a contract for a building devoted to the exhibition of antelopes. The executive committee states, however, that if the menagerie is to equal the best European institutions of a like nature, even, greater efforts in the way of new buildings must be made in the future.

Judging from the excellent reproductions of photographs with which the report is illustrated, the larger mammals are allotted ample space, and enjoy, whenever practicable, surroundings suitable to their particular requirements. This is well exemplified in the annexed illustration of a group of Barbary wild sheep in the collection.

FIG. 1.—A group of Aoudad, or Barbary wild sheep. (From Report of the New York Zoological Society.)

Perhaps the most important part of the society's work, so far, at any rate, as menagerie administration is concerned, is the establishment of a medical department on what it is hoped may be a permanent basis. In the words of the report, "the object of this service is, by systematic observation and record, and by experimental treatment, to extend our knowledge of the care and health of wild animals in captivity, the causes of various diseases, and the means which should be taken for their prevention. This is both humane and part of an economic administration." The establishment includes a well-known medical pathologist, a trained veterinarian, and an expert in microscopic investigation and the preparation of pathological cultures. To the report before us the last-named official contributes two communications of prime importance in regard to menageries, namely, one on the modes of tubercular infection in wild animals in captivity, and a second on cysticerci in wild ruminants. The work of the department in question is therefore already in full swing, and its investigations will doubtless be found of the highest value to menagerie authorities throughout the world. None of us can fail to be pained at the large percentage of ailing animals to be seen in every menagerie, and all will therefore welcome anything that can be done to render such cases less common in the future.

In addition to the aforesaid special papers and the reports of various officials, the volume before us contains other articles of interest. In one of these, for instance, Mr. R. H. Beck gives a graphic account of hunting for giant tortoises in the Galapagos Islands, illustrated by a photograph of these reptiles coming to a pool to drink, and by a second of the mode in which their empty shells are carried on mule-back to the coast. The psychology of birds forms the subject of a communication by Mr. C. W. Beebe, while Mr. R. L. Ditmars discourses on the method of feeding reptiles in captivity, with especial reference to the somewhat forcible measures adopted in the case of a recalcitrant python.

To those who make the study of mammals a speciality, as well as to big game hunters and sportsmen generally, a paper by the secretary, Mr. M. Grant, on caribou, or reindeer, will be of special interest, not only from the excellent account of the various local forms, but from the numerous illustrations by which their distinctive features are displayed. One of these we herewith reproduce, on account of its being taken from an animal in the wild state. Mr.

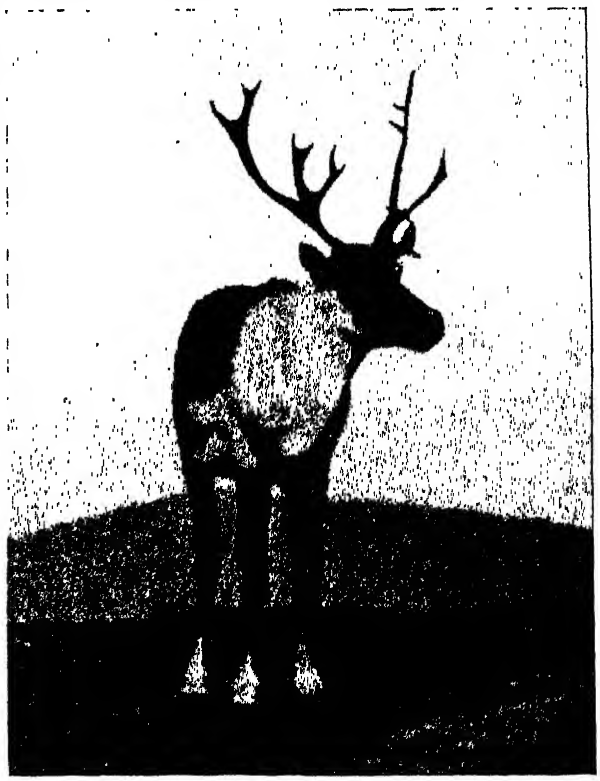


FIG. 2.—Wild Newfoundland Caribou. (From Report of the New York Zoological Society.)

Grant considers that all the American caribou may be divided into two groups, the large and light antlered barren ground group, and the woodland group, distinguished by the short, heavy, and much-branched antlers. The distribution of the various members of these two groups is illustrated in a coloured map. R. L.

THE ORIGIN OF SEED-BEARING PLANTS.[1]

WHEN Linnæus, in 1735, brought out his famous sexual system of classification, which for so long dominated systematic botany, twenty-three out of his twenty-four classes were occupied by flowering plants, and one only was left for the flowerless plants or Cryptogamia.

As the name "Cryptogamia" indicated, a thick veil of mystery still hung over the reproductive processes of these flowerless plants. When this obscurity became gradually dissipated, with the aid of improved microscopes, by the brilliant researches of Hedwig, Mirbel, Nägeli, Pringsheim, Cohn, Thuret, and above all Hofmeister, and the "Crypto-

[1] Discourse delivered at the Royal Institution on Friday, May 15, by Dr. D. H. Scott, F.R.S.

gamia," to quote a phrase of Prof. Sachs's, became the true "Phanerogamia," their relative importance received better recognition. In a recent classification—that of Prof. Warming—out of twenty-three classes no less than eighteen are assigned to Cryptogams.

In spite of our vastly increased knowledge of the Cryptogamia, the flowering plants are still in the majority as regards species. According to a recent census, out of about 175,000 known species of plants, about 100,000 or 4/7 are phanerogamic. For our present purpose we may speak of the flowering plants as the seed-bearing plants or Spermophyta, for at least in recent vegetation the two characters, the grouping of the reproductive leaves in a flower and the formation of a seed, go together, and the latter is the more definite and constant feature. The Cryptogams, such as ferns, mosses, seaweeds, and fungi, may, in contradistinction, be spoken of as the spore-bearing plants or Sporophyta. In the vegetation, then, of the present day, the seed-bearers are enormously predominant, not so much in mere number of species as in importance, including, with few exceptions, all plants of utility to man, and almost all of conspicuous stature, and occupying vastly the greater part of the earth's land surface.

To what do the now dominant seed-plants owe their success?

This is a difficult question, for all organisms are well adapted or they could not exist, and nothing requires more careful discrimination than the attempt to determine the exact factors which constitute the relative superiority of one group over another in the struggle for life. Everything depends on the conditions of the contest.

In the simpler of the higher Cryptogams, such as ordinary ferns, the spores are all of one kind, and on germination give rise to an independent plantlet, the prothallus, on which the sexual organs are borne. Fertilisation requires the presence of water for the actively moving male cells, the spermatozoids, to swim in. This condition may be something of a handicap to the plant, but if water is present, reproduction is fairly well ensured. In the more advanced spore-plants, such as the Selaginellas, so commonly grown in our greenhouses, the differentiation of the sexes begins earlier, for the spores themselves are of two kinds. There are numerous male spores of very small size (microspores) and comparatively few female spores of relatively large size (megaspores). In the group of the water-ferns (Hydropterideæ) only one of these large spores is produced in each spore-sac, which then, if provided with a special envelope, as in Azolla, may closely simulate a seed.

In the microspores, the prothallus is scarcely developed; the spore has practically nothing else to do but to produce the spermatozoids. On the female side, provision has to be made for the nutrition of the embryo, and here there is a comparatively bulky prothallus, though, as compared with that of the ferns, it tends to lose the character of an independent plant, and to become a mere storehouse of food-materials. There are certain obvious advantages in this heterosporous condition. The male spores are kept small for easy dispersal, and can be produced in correspondingly large numbers. The prothallial tissue is economised and only formed where it is wanted, *i.e.* in connection with the egg-cells from which the embryos arise.

The differentiation of microspores and megaspores is, in fact, comparable to that earlier differentiation of minute active spermatozoids, and large stationary ovum, which took place far back in the history of both animals and plants, and laid the foundation of sex.

At the same time the heterosporous arrangement, as we find it in Cryptogams, puts a new obstacle in the way of the successful accomplishment of the act of fertilisation. In order that this may happen it is necessary that the two kinds of spores should germinate together, as well as in the presence of an adequate water supply. The necessary association of the large and small spores is, as a rule, left to chance, the small spores being produced in enormous numbers, so that the chance may be a good one.

In the case of the great cryptogamic trees of the Palæozoic period the difficulty must have been a serious one. We know that their spores often differed in mass in the proportion of at least 100,000 to 1, and when bodies of such diverse weights were scattered by the wind from the tops of lofty trees, the chances must have been enormously against their coming to rest at the same spot. It was perhaps to this difficulty that the series of adaptations leading up to seed-formation owed their first inception.

If the microspores could be brought to the megaspores while the latter were still attached to the parent plant, much greater certainty of their union would be gained, for adaptations would now become possible for catching the small spores and retaining them in position. Some of the Cryptogams now living have got as far as this; the work of an American lady, Miss Lyon, has shown that in some species of Selaginella the microspores and megaspores meet and the spermatozoids are discharged within the sporangium; fertilisation is effected, and even an embryo may develop before the megaspore is shed. In this last respect these Selaginellas go beyond the seed-plants of the Palæozoic period, as we shall presently see. The first advantage, then, to be secured was the occurrence of fertilisation, or rather the bringing together of the two kinds of spore, on the parent plant. This is one of the constant characteristics of the seed-bearing plants; the process is spoken of as *pollination*, for what we call the pollen-grains are nothing but the microspores of the Spermophyta.

We will now see how the process actually goes on in some of the simpler seed-plants of the present day.

The seed-plants, as is well known, are divided into two great classes, the Angiosperms, in which the seeds are enclosed in a seed-vessel, and the Gymnosperms, in which they are exposed. In the former, fertilisation is effected by the growth of the pollen-tube through the tissues of the young seed-vessel; in the Gymnosperms the pollen falls directly upon the young seed or ovule, and the pollen-tube has only a short way to grow before reaching the egg-cell.

The Angiosperms (Monocotyledons and Dicotyledons) include practically all our familiar flowering plants, but with them we are not concerned at present. The question of the origin of Angiosperms is one of the great unsolved problems of botany, but it does not immediately touch our present subject. It is to the simpler seed-plants—the Gymnosperms—that we must turn for light on the origin of the seed-plants as a whole. The Gymnosperms are enormously the more ancient of the two classes, extending back through the whole of the Carboniferous period into the Devonian, while the Angiosperms, so far as we know, only appeared quite late in the Mesozoic period.

The most familiar of the Gymnosperms—the Coniferæ or cone-bearing trees—are themselves too far advanced on the seed-bearing line for our purpose. We will concentrate our attention on a family which, of all living flowering plants, stands nearest to the Cryptogams, namely, the Cycads. This group, not very well known to the non-botanist, but of which a splendid collection will be found in the palm-house at Kew, is now a small one, including nine genera and about seventy species, distributed through the tropical and sub-tropical regions of both the old and new worlds. In habit these plants, which may rise to the stature of small trees, bear some superficial resemblance to palms; the agreement with ferns is, however, much more striking.

In the genus Stangeria from tropical Africa, the leaves bear so close a resemblance to those of some ferns in form and veining that the plant, before its fructification was known, was described by competent botanists as a species of the fern-genus Lomaria.

In all Cycads the male fructifications are in the form of cones; the pollen-sacs are borne in great numbers on the under surface of the scales of the cone. In all the genera but one, the female fructifications are also cones, each scale bearing two large ovules. In the type genus Cycas, however, there is no specialised female cone at all. The fertile leaves are borne in rosettes on the main stem, alternating with zones of the ordinary vegetative leaves.

The fertile leaves are of large size and compound form, and usually each of them bears several ovules, which, whether fertilised or not, grow to a great size, sometimes as big as an egg-plum. They are in some species of a bright red colour, and contrasting with the yellow woolly leaves on which they are borne, are conspicuous and beautiful objects.

In thus bearing its seeds on leaves so little modified, and springing like the ordinary leaves from the main stem, Cycas is the most fern-like genus of flowering plants.

The ovule, at the time when pollination takes place, is

about the size of a small hazel nut. It consists of an outer envelope and a central body, the two being closely joined together, except towards the top, where the envelope leaves a narrow passage open, leading down to the central body. The apex of the latter becomes excavated into a hollow pit—the pollen chamber—a feature almost peculiar to Cycads amongst *living* plants, discovered by our countryman Griffith so long ago as 1854, though the credit is often wrongly given to later French or German investigators.

The pollen, blown by the wind or possibly conveyed by insects, is received in the opening of the envelope by a drop of gummy substance, and as this evaporates the pollen-grains are drawn down through the narrow passage into the pollen chamber below. There each grain anchors itself by sending out a tube into the neighbouring tissue of the ovule. Thus pollination is accomplished. Fertilisation, *i.e.* the actual union of the male and female cells, takes place some months later, when the ovule, now to all external appearance a seed, has reached its full size. In the meantime, the single megaspore or embryo-sac, embedded in the tissue of the central body of the seed, has grown to enormous dimensions—filled itself with prothallus and developed the egg-cells at its upper end, which are so large as to be easily seen with the naked eye.

The pollen-grain behaves like a cryptogamic microspore and produces two large spermatozoids, each with a spiral band bearing numerous cilia—the organs of motion. The pollen-tube becomes distended with water, bursts, and sets free the sluggishly moving spermatozoids, which by aid of the water discharged from the pollen-tubes are able to swim to the egg-cells and effect fertilisation.

This remarkable process, first discovered in 1896 by two Japanese botanists, Ikeno and Hirase, and independently in 1897 by the American Webber, occurs not only in the Cycads, but also in that strange plant the maiden-hair tree, Ginkgo, a form now completely isolated, certainly rare in a wild state, and said to have been only saved from extinction by cultivation around Buddhist temples in China and Japan, but which has a long geological history.

The cycadean method of fertilisation holds exactly the middle place between the purely cryptogamic process, where the active male cells accomplish the whole journey to the egg by their own exertions, and the method typical of seed-plants, where these cells are little more than mere passengers carried along by the growth of the pollen-tube.

The adaptations, which in the Cycads allow of pollination and fertilisation on the plant, are chiefly three:—

(1) The envelope of the seed with its narrow opening down which the pollen-grains are guided.

(2) The pollen-chamber below in which they are received.

(3) The pollen-tube which, however, plays a somewhat less important part here than in the higher flowering plants, and in the Palæozoic allies of the Cycads may perhaps have been dispensed with altogether.

There are, however, other points in which the ovule of a Cycad differs from the spore-sac of a Cryptogam. Not only is the megaspore solitary—that is a condition already reached among the water-ferns—but it is firmly embedded in the surrounding tissue. It is no longer a mere spore destined to be shed, but remains throughout an integral part of the ovule, while the ovule ripens into a seed and ultimately germinates. Thus the whole development of the prothallus takes place within the seed, and this requires special methods of food-supply, involving a complexity of structure far beyond that of any cryptogamic spore-sac. When the time for dispersal comes, the seed is shed as a whole.

There is, however, another character commonly regarded as essential to the definition of a seed; a seed should contain an embryo. This implies that, after the egg-cell has been fertilised, the young plant develops to a certain extent while still within the seed, and before it is shed. In the ripe seed the embryo passes into a resting stage, and only resumes its development when the seed begins to germinate and the embryo becomes a seedling. Usually, too, the ripening of the seed itself is dependent on the development of the embryo; if there is no fertilisation there is no true seed, only an abortive ovule.

In the Cycads this is not the case; the ovule ripens into a full-sized and apparently normal seed, even if fertilisation has failed. In our hot-houses Cycads are seldom fertilised; yet the conspicuous scarlet seeds of *Cycas revoluta*, or the crimson seeds of Encephalartos, are familiar objects to many Kew visitors. Further, the degree of development of the embryo at the time the seed is shed is very inconstant; sometimes, although fertilisation has taken place, the embryo is scarcely to be detected.

The definite resting stage of the young plant in the dry seed, so characteristic of the higher Phanerogams, is unknown to these primitive seed-bearers, the Cycads and the maidenhair-tree. The same appears to hold good for the seeds found in the Palæozoic rocks. Such seeds are common in certain localities, as in the Coal-measures of central France, and to a less degree in our own coal-beds. In petrified specimens the structure is often beautifully preserved, yet in no single case has a Palæozoic seed been found to contain an embryo. It is not merely a matter of preservation, for that is not unfrequently so good that the delicate egg-cells can still be recognised. Thus there is no known "seed" of Palæozoic age which, according to current definitions, strictly deserves the name. Technically, the term "ovule" would be more appropriate, but the obvious maturity of the integument makes the word "seed" seem more natural. So far the case is parallel to that of our recent Cycads or the maidenhair-tree.

It is, of course, possible that any day we may light on some Palæozoic seed with an embryo; it may be that the specimens hitherto found were all unfertilised, though the frequent presence of pollen-grains in the pollen-chamber makes this explanation unlikely. It seems not improbable that the development of an embryo in the ripening seed was a later device—that in the older seed-plants the period of rest came immediately after fertilisation, and that the growth of the embryo, when once started, went on rapidly and continuously to germination. In that case a seed with a recognisable embryo would rarely be preserved.

We are now in a position to see what are the chief advantages gained by a plant in adopting the seed-habit; they are:—

(1) Pollination on the parent plant, and consequently greater certainty in bringing together the two kinds of spore.

(2) Fertilisation either on the plant or at least within the sporangium, giving greater certainty of success, and protection at a critical moment.

(3) Protection of the young prothallus from external dangers.

(4) A secure water-supply during its growth.

(5) Similar protective and nutritive advantages for the young plant developed from the egg-cell.

This last end, however, was very probably not yet fully attained in the earlier seed-bearing plants.

We may now go on to consider our main subject—the historical question, from what group of spore-bearing plants were the seed-plants derived?

One thing is plain; the stage of heterospory was the immediate precursor of seed-formation, and it was from some group of Cryptogams producing spores of two kinds that the seed-plants sprang. Such heterosporous groups are, however, known in three of the main phyla of the higher Cryptogams.

In the Lycopod series we have, among their living representatives, pronounced heterospory in Selaginella and Isoetes; among the Palæozoic Lycopods it was commoner still. Within the class of the ferns we have the heterosporous water-ferns. In the third series, that of the horsetails, we have, it is true, only homosporous forms now living, but in Palæozoic times a well-marked differentiation of micro- and megaspores was attained, though less extreme than in the other two lines.

So far, therefore, there is no reason why the early seed-plants might not have had family relations with any of these great cryptogamic classes, and, as a matter of fact, all three lines have been championed by one botanist or another as the probable ancestors of the seed-plants.

The horsetail stock, though it attained an extraordinary development, shows no further sign of transition towards the higher plants.

The case for the Lycopods is stronger, and, indeed, they were long the "favourites," and were commonly regarded as lying nearest the true line of spermophytic descent. This idea was specially based on the mode of development

of the spore-sacs, which has much in common with that of the pollen-sacs and ovules of Phanerogams, and this, combined with the occurrence of well-marked heterospory in some genera, appeared to point to a relationship. But the former character (the development of the spore-sac from a group of cells instead of from a single one) is now known to be common to certain ferns, and to just those ferns (the Marattiaceæ, &c.) which prove to be the most ancient, so that this argument has lost its weight. It has lately been found, indeed, that some of the Carboniferous Lycopods produced seed-like organs, presenting the most striking analogies with true seeds, but the plants which bore them were in all other respects Lycopods pure and simple, and the case appears to have been one of homoplastic modification. There is no indication, as yet, of any forms really transitional between the Lycopods and the Spermophyta.

The one line which, so far, has yielded truly intermediate types is that of the ferns.

Among recent plants, the Cycads, as we have seen, offer some points of agreement with ferns, sufficient to have led certain distinguished botanists, for example Sachs and Warming, strongly to maintain their fern-ancestry. The chief points of agreement are:—

(1) The fern-like foliage in some Cycads, and in many the mode of folding of the leaflets in the bud.

(2) The arrangement of the pollen-sacs in groups on the underside of the cone-scales, like that of the spore-sacs of ferns on the underside of the leaves.

(3) The carpels or fertile leaves of Cycas, which, though bearing true seeds, are more like fertile fern-fronds than any other reproductive leaves.

By themselves, these characters, though suggestive, would be inconclusive; the anatomy is not directly comparable with that of any living ferns.

What, then, do we know of the history of this family in past times? The Cycads are now a small and isolated group; in the Mesozoic period, from the Trias to the Lower Cretaceous, they were one of the dominant types of vegetation, and spread all over the world. Of the fossil species recorded from the Oolite of the Yorkshire coast and from the Wealden of the south of England, one-third are referred to Cycads, and they were equally abundant in the Mesozoic floras of North America, India, and other countries. If they existed in the same proportion now as then, they would have about 35,000 species instead of 70! The Cycads of the Mesozoic, however, were not, as they are now, a single family, but a great class (the Cycadophyta of Nathorst) embracing very diverse types, often with organs of reproduction widely different from those of their surviving relatives, and showing a certain parallelism with angiospermous fructifications. But with all this there was on the whole a remarkable uniformity in habit, just as we find a general similarity in outward characters among so many dicotyledonous trees of the present day, though belonging to the most diverse families.

In the Mesozoic rocks we also find a certain number of plants (known only from their foliage) as to which it remains doubtful whether they belonged to Cycads or ferns, or to some intermediate group.

Besides the Cycadophyta, seed-plants were represented in Mesozoic days by a great number of Coniferæ, more or less allied to those still living, and by various forms akin to the maidenhair-tree, perhaps the more ancient type surviving in the recent flora.

When we go further back, to the Palæozoic rocks, it is only in their uppermost strata that we find forms clearly referable to Cycads or Conifers.

The best known seed-bearing plants of the older rocks are those of the family Cordaiteæ, which stretches back to the Devonian. They were tall, branched trees, bearing great simple leaves, sometimes a yard long. The anatomy of stem and root resembled that of an Araucarian Conifer, but the leaves had just the structure of the leaflets of a Cycad. Male and female flowers were borne in little spikes or catkins, and may best be compared with those of the maidenhair-tree. The seeds, of which the structure is known, closely resemble those of that plant, or of recent Cycads.

The Cordaiteæ, however, ancient as they are, were already pronounced gymnospermous seed-plants—by themselves they give no direct clue to the origin of Spermophyta. We must look elsewhere for the key to our main problem.

The vast number and variety of fern-like remains throughout the Palæozoic strata, wherever land-plants are known, is familiar to all. Almost every form of recent fern-frond can be matched from the impressions in the Carboniferous and Devonian rocks. A considerable number of these fossil fern-fronds are known to have really belonged to ferns, for typical fern-fructifications are found upon them. An experienced collector of Coal-measure plants, Mr. Hemingway, once told me that he reckoned on finding about 20 per cent. of the specimens of any true fossil fern in the fertile state. When, therefore, a common fossil fern-frond (so-called) is *never* found fertile, a strong suspicion is awakened that the plant must have had some kind of fructification other than that of an ordinary fern. This is the case with a surprisingly large proportion of the Palæozoic plants commonly described as ferns, and holds good of certain entire "genera"; the important genera Alethopteris, Neuropteris, Mariopteris, Callipteris, Tæniopteris, and others, have never yet been found, in any of their species, with fertile fronds, if we except one or two specimens so questionable and obscure that no conclusion can be drawn from them. It is probably under the mark to say that one-third of the so-called ferns of Palæozoic age afford no evidence from fructification that they were really ferns, as we now define them.

The absence of recognisable fertile fronds may, it is true, be partly accounted for by dimorphism. Many ferns, both recent and fossil, bear their reproductive organs on modified portions of the frond, or even on special fronds, very different from the vegetative foliage. Fossil remains are usually fragmentary, and when the sterile and fertile fronds are found isolated, there may be nothing to show that the one belonged to the other. But, allowing for this, there are very many "fern-fronds" which offer no evidence, even from association, of any fern-like fructification, while the fructifications actually associated with them are often anything but fern-like. There are, in fact, a number of unassigned seeds from the Coal-measures, some of which are commonly associated with certain of the quasi-ferns of which we are speaking.

On the whole, however, we have, up to this point, had before us merely negative evidence, indicating that many of the leaves, so familiar to palæobotanists, classed on account of their form and veining as fern-fronds may really have belonged to some group different from the true ferns. Negative evidence is notoriously weak; at most it only justifies us in taking up a position of philosophic doubt, though in this case it was enough to induce the distinguished Austrian palæobotanist Stur to suspect that the genera Alethopteris, Neuropteris, and others were not ferns, but Cycads.

During the last thirty years, however, positive evidence has been accumulating proving that certain of the fern-like Palæozoic plants were at any rate something distinct from true ferns, as we now know them. This evidence is derived from a study of the anatomical structure, which in Cycads and ferns, as they now exist, is sufficiently different to prevent any possible confusion between the two groups. A single section from the leaf-stalk of the fern-like Cycad Stangeria would be enough to show that it is a true Cycad and no fern, and conversely, a single section from the frond of Lomaria, with which Stangeria was once confused, would show it to be a true fern and not a Cycad.

A common Coal-measure plant, named *Lyginodendron Oldhamium*, was one of the first of the Palæozoic quasi-ferns to be examined anatomically. We owe this work, like so many other great advances in fossil botany, to the late Prof. Williamson, who thus led the way to the solution of the problem before us.

Externally, the plant is wholly fern-like; its characteristic highly compound foliage is that of a Sphenopteris (*S. Höninghausi*) with a Davallia-like habit. The large fronds were borne, at intervals, on a somewhat slender stem, which rooted freely. The slender proportions and the presence of spines everywhere, on leaf and stem, suggest that the plant may have been a scrambling climber like *Davallia aculeata*, for example, among recent ferns.

The structure of all the vegetative parts of the plant, stem, leaf, and root, is known as perfectly, perhaps, as in any plant now living. The leaves turn out to be

true "fern-fronds" in structure as well as in external aspect. The vascular bundle traversing the petiole, for example, is of the "concentric" type characteristic of ferns, and any differences there may be are in details only.

A section of the stem, however, bears at first sight no resemblance to that of a fern; outside the pith we find, in all mature specimens, a broad zone of wood and bast with its cells arranged regularly in radial series, like that of an ordinary "exogenous" tree, and in detail approaching especially the cycadean structure. At the border of the pith there are distinct strands of wood, and this region, which was laid down before the radially arranged zone, recalls the structure of an Osmunda. The bundles in the cortex of the stem, on their way out to the leaves, have, in this part of their course, exactly the structure of the strands in the leaf-stalk of a Cycad—a structure found, in this form, in no other living plants.

The roots, when young, resembled those of certain ferns (Marattiaceæ), but as they grew older they also formed radially arranged wood and bast like the roots of Gymnosperms.

On the ground of this remarkable combination of structural characters, it was inferred that Lyginodendron could not have been a true fern, but must have occupied a position intermediate between the ferns and the cycadean type of Gymnosperms.

A similar association of diverse anatomical characters has now been proved to exist in various other quasi-ferns of Palæozoic age. In Heterangium, for example, also investigated by Williamson, leaves and roots resemble those of the previous genus, but the stem is more obviously fern-like, agreeing in its earlier stages with that of a Gleichenia, but acquiring, with advancing age, a zone of secondary wood and bast of the cycadean type. This plant likewise bore foliage of the Sphenopteris form (*S. elegans*).

In Medullosa, on the other hand, to which the Alethopteris and Neuropteris foliage belonged, the original ground-plan of the tissues in the stem is like that of a complex fern, but the structure of leaves and roots, and the secondary structure of the stem itself, is almost purely cycadean. We might continue the list much further. Wherever one of these quasi-ferns has been examined anatomically, a similar combination of characters has been found. It may be pointed out in passing that, while many of these intermediate forms lead on towards the Cycadophyta themselves, others approach more nearly to the extinct family Cordaiteæ, and indicate that they also, though so different from ferns in habit, may yet have sprung from the same stock.

But so far the positive evidence has been wholly anatomical, and botanists are not yet altogether in agreement as to the value of anatomical characters. The anatomist very naturally thinks that there is nothing like anatomy, but the pure systematist will not be satisfied without the characters on which he has been accustomed to rely, and his faith in which has been so amply justified, those, namely, drawn from the reproductive organs. Darwin, however, who neglected nothing, was fully alive to the importance of anatomical evidence; he expresses his interest in an anatomical character in an amusing way in one of his lately published letters (1861), saying, "The destiny of the whole human race is as nothing compared to the course of vessels in Orchids!"

Until the present year, we had no satisfactory knowledge of the fructification in any one of the Cycadofilices, as we now call them, of the Palæozoic period. There is, it is true, some reason to believe that a form of fructification with long tufted spore-sacs belonged to Lyginodendron, but we know nothing as yet as to the details—it may prove to represent the male reproductive organs of the plant. Among the unidentified seeds of the Coal-measures, there are some—the great seeds known as Trigonocarpon—which are not only associated with Medullosa, but which show a certain structural resemblance to some of its tissues. But still the indications were slight—so slight that Prof. Zeiller, of Paris, than whom there is no higher authority, has recently expressed a doubt whether these Cycadofilices were, after all, anything more than a peculiar group of ferns.

Within the last few months, however, an altogether new light has fallen on our subject. Among the seeds discovered by Williamson in the English Coal-measures were three species which he placed in his genus Lagenostoma. These, as we shall see, are characteristic seeds of complex structure. One of them, named *L. Lomaxi* by Williamson, though not described by him, has lately been reinvestigated, in the first instance by my friend Prof. F. W. Oliver (see NATURE, June 4). The great peculiarity about it is that the seed itself was borne in a little calyx-like cup, fitting loosely round it, just as a hazel nut is borne in its husk. The cup, or cupule, which is deeply lobed, bears very peculiar glandular bodies, usually with a short thick stalk and a round head which is empty, as if the secretory tissue had broken down. These glands, on the cupule of the seed, have been found to agree exactly in dimensions, form, and structure with the glands borne on the leaves and stems of the particular form of *Lyginodendron Oldhamium* with which the seeds are associated.

Suppose that in some tropical forest where the trees were too lofty for their leaves and fruits to be reached, seeds and leaves and twigs were found scattered together on the ground, and that they all proved to bear exactly similar glandular outgrowths of a kind unknown elsewhere. Suppose, further, that the structure of the envelope of the seed turned out to agree in other respects with that of the vegetative fragments, should we hesitate to conclude that the seeds belonged to the same plants as the leaves and twigs, though we had never seen them actually in connection? Such is the argument with regard to the relation of the seed Lagenostoma to the plant Lyginodendron. Short of finding the vegetative and reproductive organs in continuity, the proof is as strong as it can be, and I think we need not hesitate to conclude that the one belonged to the other.

But, if this be so, the question as to the nature of the Palæozoic Cycadofilices is settled, at least as regards one member of the group. Lyginodendron was already a seed-bearing plant. The seeds are highly organised, and, broadly speaking, of the cycadean type. The integument and central body of the seed are closely joined to near the tip and along the line of junction run the strands which conveyed the water-supply. The upper part of the integument has a curious chambered structure—the central body terminates in a large pollen-chamber of peculiar bell-shaped form, in which the pollen-grains are sometimes found. The neck of the pollen-chamber fits into the opening of the integument and reaches the surface. The centre of the seed is occupied by the large megaspore or embryo-sac, in which remains of prothallial tissue can sometimes be detected. The seed, in fact, is as highly differentiated as any seed of its period, lacking only an embryo, as do all its contemporaries.

But if Lyginodendron, with all its fern-like characters, was thus a true seed-plant, we cannot doubt that other quasi-ferns of that period, exhibiting a similar combination of characters, had also entered the ranks of the Spermophyta, and we may confidently expect that, one by one, many of the as yet unowned Palæozoic seeds will be traced to their fern-like possessors.

Further positive indications of this are already presenting themselves. For example, there is a specimen in the British Museum collection showing a cast of a branched rachis accompanied by a multitude of ribbed seeds, many of which are in clear connection with the rachis itself. At one place we see a leaflet of *Sphenopteris obtusiloba,* a well-known Coal-measure "fern," and everything indicates that we have here the fertile, seed-bearing rachis of that species. There are other specimens which point in the same direction, and now that the eyes of collectors are opened to the possibility of their so-called "fern-fronds" bearing seeds—an idea which before seemed too improbable to be entertained—more of such specimens will doubtless find their way into our museums.

The present position, then, of our question is this. Some, probably many, of the fern-like plants of Palæozoic age bore seeds of the same general structure as those of the Cycads among living Gymnosperms. The plants in question were not merely fern-like; their anatomical structure proves them to have had so much in common with true ferns that there can be no doubt of their affinity with them. In fact, apart from the newly discovered seeds, these plants, for the most part, show a balance of characters on the fern side.

The evidence thus points unmistakably to the conclusion

that the Cycadophyta—the most primitive of the seed-plants—sprang from the fern stock. Thus the origin of the great mass of cycadean forms which overspread the world during the Mesozoic epoch is accounted for—they were doubtless derived from the more primitive Cycad-ferns of the preceding Palæozoic age, and through them from some early filicinean ancestry. The first divergence from this original cryptogamic stock must have occurred very far back; the seeds of Lyginodendron and other Carboniferous seeds referable to the Cycadofilices are, as we have seen, already highly organised, and the stages of their evolution from the cryptogamic sporangium are still to be discovered.

The origin of the seed-plants from the fern phylum will probably prove to hold good for other groups besides the Cycadophyta. The great Palæozoic family Cordaiteæ combines the characters of Cycads and Coniferæ, and at the same time shares certain of those anatomical features which first betrayed the true nature of the Cycadofilices. There is thus a strong presumption that the Cycadophyta, the Cordaiteæ, and the Coniferæ themselves had a common origin, or at least that they all sprang, directly or indirectly, from the great plexus of modified ferns which played so large a part in Palæozoic vegetation.

Hence, so far as the gymnospermous seed-plants are concerned, we are led to the conclusion that they were derived, at a very early period, from the fern stock. The following up of the clue, which, as I believe, we have now grasped, will afford a pursuit of the utmost interest and promise.

But the other great problem—the origin of the angiospermous seed-plants, which are now supreme in the vegetable world—is as yet untouched. And so, though real progress has been made, it will be long before we can hope for a complete answer to the question which we have had before us.

THE GOVERNMENT LABORATORY.

THE report of Dr. T. E. Thorpe, F.R.S., upon the work of the Government Laboratory for the year ended March 31, 1903, with appendices, has now been published, and the following extracts from it are of interest.

It appears from the report that the descriptions of imports as given in merchants' entries are often erratic, and give no clue whatever to the real nature of the goods. For example, crushed bones were entered as "semolina," gingerbread as "paints," sodium peroxide as "fancy goods," varnish as "iron goods," whilst "machinery" and "razor strops" turned out to be tobacco fumigating powder and sugar-coated pills respectively.

Many preparations containing spirit are liable to duty also in respect of other ingredients. Soaps, for example, may contain cocoa-butter, spirit and sugar, the latter being frequently used as a cheap substitute for glycerine. Blacking and polishes are examined for sugar or molasses; confectionery for sugar and chocolate; and essences for dutiable tariff articles, in addition to spirit, such as acetic and butyric ether, used for flavouring purposes.

During the year 1173 samples of beer, wort, and brewing materials were tested for the presence of arsenic, the great majority of which were either quite free from that impurity or contained only traces; but in 44 instances the amount was so notable that the brewers were informed in the case of materials that they should not be used, and in the case of wort or beer that it should not be sent into consumption. The largest quantity of arsenious oxide found was, in malt, 1/50th of a grain per pound, in glucose, 1/40th of a grain per pound, in wort, 1/36th of a grain per gallon, and in water-softening material, 7/10ths of a grain per gallon.

No imported sample of butter has been reported as adulterated during the year. Boric acid preservative was present in 98 per cent. of the samples of butter from Australia and Belgium, 86 per cent. of the French samples, 78 per cent. of those from New Zealand, 77 per cent. of the South American samples, 45 per cent. of those from Holland, and 43 per cent. of the samples from the United States. Sixteen per cent. of the Canadian samples contained this preservative. There has been a decrease in the proportion of samples containing boric preservative from 36·3 per cent. in 1902 to 33·5 per cent. in 1903, for which the samples from Holland are chiefly responsible.

Among articles submitted by manufacturers to the Government Laboratory was a filter which was required to deliver a sterile filtrate, but on examination was found to permit the passage of unfiltered water into the reservoir to which only filtered water was supposed to gain access. This is a danger to which insufficient attention appears to be paid by both manufacturers and users of filters. The inefficiency of many of the old filters was long since established, and as a result improvement was effected in the filtering substance, so as to secure that the water passing through should be free from all micro-organisms. In consequence of the precautions necessary where biological investigations are made, it is to be feared that in some instances, when testing the sterility of the filtrate, the filtering cylinders, cones, or candles, have been examined apart from the filter cases in which they are ordinarily fixed, and no subsequent test has been made of the filter as a whole, with its parts fitted together as in common use. Where this is so it is, of course, possible that though the filtering cylinder itself may be entirely satisfactory, its whole value may be destroyed by a faulty connection.

Among work undertaken for the Home Office was an investigation of the character of the products of combustion in gas and oil stoves. It was desired to ascertain whether along with the main products of complete combustion there was an appreciable production of carbon monoxide and acetylene. Five of the best known stoves—three gas and two oil—were experimented with, and, as a result, it was found after the stoves had been alight for some time (1) that no acetylene was produced by any of the stoves, and (2) that a small amount of carbon monoxide was a regular constituent of the products of combustion of all the stoves, the actual quantity per hour's combustion being, for the gas stoves 0·0024, 0·0048 and 0·0480 cubic foot, and for the oil stoves 0·023 and 0·032 cubic foot.

Of the gas stoves, the first two results quoted were from stoves of different type, the first being of the argand class and burning with a luminous flame, whilst in the second the burners were of the Bunsen type, and the flame impinged on skeleton non-combustible fuel. The production of carbon monoxide is greater in the oil stoves than in two out of the three gas stoves, and it emphasises the necessity of carrying off the products of combustion from every class of stove by means of a flue, if possible, or, where this actually cannot be attained, at least securing that, by good ventilation, there shall be no chance of an accumulation of these gaseous products.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE report has been issued of the commission appointed to inquire into the steps to be taken to bring into existence an institution which should form part of a teaching university for the Transvaal, and which should provide the highest training in the arts and sciences connected with mining and other industries. The commission recommends that, in establishing the proposed technical institute to form an integral part of a teaching university, simultaneous steps should be taken to lay the foundations of the university itself. Recommendations are made for the establishment of a permanent teaching institution and the acquisition of a site within a convenient distance of Johannesburg and Pretoria for a teaching university for the Transvaal, and for any other parts of South Africa which may wish to take part in the scheme. On this site should also be, besides the school of mines, the proposed agricultural school, the State laboratories for chemistry and animal and vegetable pathology. At the outset the appointment is recommended of a principal of the highest scientific attainments and proved organising capacity, with a salary of not less than 3000*l*. a year.

THE Columbia University of New York has, by an agreement with Mr. Joseph Pulitzer, undertaken to establish and conduct a school of journalism. President Eliot, of Harvard University, has proposed an outline for a practical scheme which details the subjects appropriate to a course

of study leading to the profession of journalism. But though Dr. Eliot says "that a journalist needs, more than most men, to be trained in the best methods of ascertaining truth," his scheme does not appear to include a provision for the due instruction of the future journalist in the broad principles of science, which, in view of the large part taken by scientific questions in modern life, seems an omission.

THE Commission of Inquiry into the educational systems of the United States in their bearing upon national commerce and industry, projected last year by Mr. Alfred Mosely, C.M.G., will start on October 3. The itinerary of the commission, drawn up with the assistance of President Butler, of Columbia University, embraces most of the leading educational centres in the United States. Among universities which will be visited may be mentioned Columbia, Yale, Harvard, Cornell, and Pennsylvania, and in addition to the work of these seats of learning, the commission will study the methods, equipment, and curricula of technical colleges and secondary schools for boys and girls, and be given opportunities to examine the procedure of educational institutions of special types. Each member of the commission will, we understand, be invited to record his own impressions, or to combine, if he prefers it, with others interested in the same subjects of education. In this way more varied light will be brought to bear upon all the points in American education. The reports will be printed in a volume or volumes, and distributed to educational bodies throughout the United Kingdom. In an article on the commission in the *Times*, it is stated that "the startling growth of American and German industrial competition is a fact, and a daily more alarming fact. Closely related with it, and in the opinion of many keen observers, largely responsible for it, is the fact that these are precisely the two countries in which national education of all grades has made the greatest strides, and in which its importance is most widely recognised by the people at large." These truths have long been insisted upon in these columns, and we are glad to find they are coming to be more generally appreciated, for it brings us nearer to the day when this country will be properly equipped educationally. The list of commissioners includes with others the following names:—Prof. W. E. Ayrton, F.R.S., Mr. R. Blair, Dr. J. Rose Bradford, F.R.S., Dr. Magnus Maclean, Principal Reichel, Prof. John Rhys, and Prof. W. Ripper.

THE Royal Geographical Society, in response to requests from various school authorities, recently appointed a committee to draw up syllabuses in geography to guide teachers in elementary and secondary schools in their work of imparting geographical knowledge. This committee secured the assistance of Mr. H. J. Mackinder to draw up the syllabus for secondary schools, and of the late Mr. T. G. Rooper to prepare that for elementary schools. Owing to Mr. Rooper's death, Mr. G. G. Chisholm consented to complete the revision of the latter syllabus. The course laid down for elementary schools includes first a preliminary stage for children between five and eight years, who are, it is said, best taught by reading to them suitable extracts from books of famous travellers, and accompanying the readings by the explanation, with the aid of sand-trays, &c., of geographical terms. The second stage is that for children between eight and eleven years old, and includes observational preparation with a view to the necessity of reading maps. Some observations within the reach of town children suggested are the use of the globe, the acquirement of the idea of direction and differences in elevation, and their representation on maps. Country children are, in addition, to learn the use of the compass and to compare Ordnance maps of the same district on different scales. In all study of maps the same ideas must be emphasised as in the observational work. In the third stage children of eleven to fourteen years old begin the systematic study of various parts of the world, and such subjects as climate, rainfall, temperature; the connection between geography and history are also insisted upon. The syllabus for secondary schools is divided into four years' work, and the years between thirteen and seventeen are particularly concerned—in fact, the student is supposed to have mastered the contents of the elementary schedule. In the first year it is proposed that a portion of Britain, extending some distance from the school, should be carefully studied. The portion should be large enough to contain complete examples of river-basins, and such lengths of road and rail to show the influence of physical features on their course. The work should be correlated with instruction in elementary geology. In the second year, Britain as a whole is prescribed as the subject of study, and its several parts are to be traversed by the comparative method, the work of the first year being the standard. For the third year the subject suggested is Europe and the Mediterranean, and it is proposed that the complexion of the teaching shall depend on the other work of the school. The non-European portions of the globe are reserved for the fourth year's work. "What is essential throughout is that nothing should be taught as an isolated fact, and yet that the line of argument should be so chosen that, in the end, every essential fact . . . would have been learnt in its due setting of related facts, and in its proper perspective."

THE report of the Technical Education Committee of the Derbyshire County Council for the session 1901–2 has reached us, and contains detailed statistical information as to recent progress in secondary and technical education in Derbyshire. The statistics relating to the subject of mining are of especial interest. Prior to 1891 not more than twenty students appear to have been attending public classes in this subject, whilst the average enrolment in local classes in coal mining for the past eight years has been about 500. It is also mentioned that, whereas at the time of the initiation of the scholarship scheme in Derbyshire in 1892 only six out of sixty successful candidates were sent to schools in the county, at the present time, out of about 250 minor scholarships, 230 are being held at schools within the administrative county, and only twenty at schools outside the administrative area.

THE catalogue of books on the useful arts contained in the central library at Newcastle-upon-Tyne, which was recently published by the Public Libraries Committee of the city, is the third of a useful series of catalogues prepared by Mr. Basil Anderton, chief librarian. The catalogues provide satisfactory evidence that students residing in Newcastle have at their disposal an excellent library conducted with tact and intelligence. The useful arts dealt with in the present catalogue include all branches of agricultural, chemical, engineering, and mechanical technology, as well as many aspects of medical and domestic science. Some idea of the number of books in the Newcastle central library may be obtained from the statement that the author-list of books on the useful arts runs to 115 closely printed pages of large size.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, July 6.—Principal Sir Wm. Turner, K.C.B., in the chair.—Mr. William **Murray** communicated a paper on statistical evidence regarding the influence of artificial propagation upon the salmon fisheries of the American rivers.—In a paper on the origin of the pineal body as an amesial structure deduced from the study of its development in Amphibia, Dr. John **Cameron** showed that the epiphysis in certain types of Amphibia arose in the form of two recesses or outgrowths from the roof of the fore-brain. The right outgrowth disappeared very early by blending with the left. The latter showed most active growth, and the result of this was to cause the epiphysial opening to become situated to the left of the mesial plane in most cases. The epiphysis in Amphibia was therefore to be regarded as a bilateral, and not as a mesial, structure. These results corresponded in the main with those of Béraneck, Dendy, Gaskell, Hill, and Locy in other vertebrate types.—Dr. O. Charnock **Bradley** communicated an elaborate paper on the abdominal viscera of *Cercocebus fuliginosus* and *Lagothrix humboldti*.—Mr. A. Cameron **Smith** described his final form of apparatus for determining by a direct method latent heats of evaporation at the boiling point in electrical units. The essence of the method is to determine the electrical energy required to effect the evaporation of a measured mass of the liquid. The energy

was supplied by a large current through a small resistance immersed in the liquid. The vessel containing the liquid was surrounded by a double-walled shield filled with the saturated vapour of the liquid itself, and the mass evaporated was measured by weighing on a delicate balance. To have the vessel hanging freely from the one arm of the balance and yet to keep it practically surrounded with the saturated vapour were among the principal difficulties to be surmounted. Promising results had already been obtained.—Dr. Thomas **Muir** communicated a note on a special circulant considered by Catalan.

PARIS.

Academy of Sciences, August 10.—M. Albert Gaudry in the chair.—The president announced to the Academy the death of M. Munier-Chalmas, member of the section of mineralogy.—On aërodynamics and the theory of the acoustical field, by M. le Général **Sebert**. Remarks on the theory of M. Charbonnier on the waves set up in air by projectiles moving with a greater velocity than that of sound.—Description of a new apparatus for the preparation of pure gases, by M. Henri **Moissan**. The gases are dried by cooling to about $-70°$, and then liquefied by boiling oxygen or air; substances gaseous at this latter temperature are removed by the mercury pump, and the pure gas allowed to boil off into a suitable gasholder. Details are given for carbon dioxide, hydrogen iodide, hydrogen phosphide, and sulphide. By the use of suitable temperatures the gas obtained from copper and dilute nitric acid was separated into water, nitrous oxide, nitric oxide, and nitrogen.—On the mechanical analysis of soils, by M. Th. **Schlœsing**, sen. An apparatus is described permitting of the mechanical separation of earth into fractions depending on the time taken to deposit from water. A microscopical examination of the deposits showed that the size of the deposited grains varied with the time required to fall out. Grains less than 0·005mm. remain in suspension in pure water for an indefinite time.—Corrections relating to a note of M. Armand **Gautier** on the estimation of arsenic in sea water, common salt, mineral water, and reagents. In the original note, by an error, there is a confusion between milligrammes and thousandths of a milligramme which is here rectified.—On the death of M. Prosper Henry, by M. **Janssen**.—On the relations between the complete integrals of S. Lie and Lagrange, by M. N. **Saltykow**.—The theory of the acoustical field and the internal friction of gases, by M. P. **Charbonnier**.—The appearance of Bishop's Circle in 1903, by M. F. A. **Forel**. This phenomenon, which appeared last in 1884, after the Krakatoa eruption, has been noticed again this year, and is considered by the author to be connected with the eruptions at Martinique.—On some binary compounds of uranium, by M. A. **Colani**. Compounds of uranium with sulphur, selenium, tellurium, nitrogen, phosphorus, arsenic, and antimony are described.—The nature of the alkaline reaction of the blood and its estimation, by M. H. **Labbé**. The alkalinity is not completely removed by the precipitation of the phosphates by barium chloride, and it is this residual alkalinity which is most strongly affected by pathological variations.—Phenols and phenolsulphonic acid in the animal economy, by M. L. **Monfet**.—On the passage of the Rhine by the Doubs valley and Bresse valley during the Pliocene age, by M. le Général **de Lamothe**.

NEW SOUTH WALES.

Linnean Society, June 24.—Dr. T. Storie Dixson, president, in the chair.—On the botany of the Darling, N.S.W., by Mr. Fred. **Turner**. The characteristics of the flora of the country lying between 29° and 33° S. lat., and 141° and 147° E. long., are discussed. The census of the Phanerogams and vascular Cryptogams now brought forward gives a total of 314 genera and 760 species.—The corpus luteum of *Dasyurus viverrinus*, with observations on the growth and atrophy of the Graafian follicle, by Dr. F. P. **Sandes**. The chief conclusions arrived at in this investigation may be thus summarised:—(1) The characteristic cells of the corpus luteum are formed by hypertrophy of the cells of the membrana granulosa. (2) The theca interna folliculi is rudimentary, and forms only the vascular connective tissue of the corpus luteum. (3) The corpus luteum atreticum is formed in the same way as the corpus luteum verum. (4) Other atresic follicles are reduced to fibrous tissue or remain cystic. (5) The corpus luteum is probably a gland with an internal secretion of use in the organism. It has the function of stopping ovulation during pregnancy and at the cestral periods.—Notes on the genus Psychopsis, Newm., with descriptions of new species, by Mr. W. W. **Froggatt**. Three species of the genus were noticed in a previous paper in the *Proceedings* for 1902. From the study of a fine series of specimens acquired in the interval, the author is now able to show that it has been customary to apply Newman's name, *P. mimica*, to what are in reality the representatives of two different species. These are differentiated; a second species from Queensland is also described as new, raising the total to five.—Notes on Prosobranchiata. No. 3. The neanic shell of *Melo diadema*, Lamk., and the definition of the nepionic stage in the gasteropod mollusc, by Mr. H. Leighton **Kesteven**. A description of the mass of egg-capsules of *M. diadema* is given, and attention is directed to the sequence of the acquisition of the columellar plaits which, in this species, is in perfect conformity with a phylogenetic scheme of their origin advanced by Dr. Dall in 1890. Then follows a comparison of the molluscan stages of development with those of the Lepidoptera.—The continental origin of Fiji, by Mr. W. G. **Woolnough**. Part i., general geology. The author's provisional conclusions are:—(1) That Viti Levu, the chief island of the Fiji group, was part of a continental area probably united to New Hebrides and New Caledonia during early Palæozoic time, and that it remained a land area undergoing denudation probably to at least the close of Palæozoic time. (2) That in Mesozoic time and Older Tertiary time subsidence predominated in the Fiji area, the subsidence at Drau, in Viti Levu, carrying the island at least about 1300 feet further below the sea than it is at present. During this period the Fiji Soapstone was deposited. (3) In late Cainozoic time elevation set in, and synchronously with it occurred violent and extensive eruptions of andesitic dolerite and basalt. Elevation has continued into late Cainozoic time, and may be still in progress. On the whole, therefore, negative movement of the land has probably greatly predominated over positive movement since Palæozoic times.

CONTENTS.

THURSDAY, AUGUST 27, 1903.

ALCOHOLIC FERMENTATION.

Die Zymasegärung Untersuchungen über den Inhalt der Hefezellen und die biologische Seite des Gärungsproblems. By Eduard Buchner, Hans Buchner, and Martin Hahn. Pp. viii + 416. (München: Oldenbourg.) Price 12 marks.

IN the preface to this book, written by Profs. Eduard Buchner and Martin Hahn, credit is given to the late Prof. Hans Buchner for the general scheme of arrangement which has been carried out after his death by the other authors.

There are four parts to the treatise; the first, by Prof. Eduard Buchner, entitled "Über die Zymasegärung," occupies nearly three-quarters of the entire book, and deals with the important researches of this author and others on the soluble ferment first separated by him from yeast-cells and called *zymase*, the ferment which induces alcoholic fermentation of sugar.

His original papers on the subject have appeared in contributions to scientific journals since the end of 1896, and are now presented in book form.

After a brief historical review of the development of ideas on the subject of alcoholic fermentation, and a comparison of Liebig's and Pasteur's theories with regard to this process, he discusses the nature of "zymase," which he brings into the category of the enzymes, or soluble ferments. A very full and complete account is given of the method of preparing "active" yeast-juice, the main steps of which are now familiar to all students of the subject. Especial stress is laid on the powdering of the yeast-cells with quartz sand in order to break up the cell-membranes. Without this, no amount of pressure avails for getting active juice from the cells, while, after breaking the cells, comparatively little pressure will give some active juice, increase of pressure increasing both the activity and the yield. The activity of yeast-juice, *i.e.* its capacity for inducing the alcoholic fermentation of sugar, varies with different species of yeasts; no conclusion as to richness in zymase can be drawn directly from observed variations in activity, as yeast-juice contains, besides several previously discovered ferments, one, endotryptase, which digests and destroys zymase, and this is present in very variable amounts in the different yeasts. Juices also of very different activity are obtained from different batches of the same variety of yeast. These differences are partly explained by the action of endotryptase on zymase.

The method of determining the "activity," dependent as it is on these conflicting factors, is fully described, and consists in the estimation of the quantity of carbon dioxide formed in a given time under standard conditions.

When the juice is collected in fractions, the first fraction that is pressed out shows least activity, and the activity increases with successive fractions to the last, so that methods which give a small yield may also give juice of relatively small activity. The most active juice is much less active than fresh yeast, and the explanation is that in fermentation with the latter there is always a fresh production of zymase. The so-called self-fermentation of yeast-juice is fully discussed, and shown to be a function of the glycogen content. Some interesting results are recorded in the fermenting of sugars other than glucose. For instance, glucose and fructose are fermented equally fast by the yeast-juice, whereas fresh yeast ferments glucose the more quickly. The author explains this as due to the fructose having a lower rate of diffusion into the yeast-cell. Similarly, glycogen was fermented by yeast-juice obtained from yeast which, in the fresh state, did not ferment this carbohydrate, the explanation being that the glycogen cannot diffuse through the cell-membrane. The experimental proof that the juice can ferment glycogen is an interesting confirmation of what has been induced theoretically, viz. that any cell which can synthesise glycogen must be capable also of hydrolysing it, at least intracellularly. It explains the phenomenon of "self-fermentation," and accords with the new theory of the reversible action of ferments.

The discussion on the mode of action of antiseptics is interesting, but not always convincing. As regards chloroform, the hypothesis is adopted that living cells are subdivided into separate workshops by partitions of cholesterin (Overton), which the author thinks may be injured by the drug and thus allow of a mingling of substances which ought to be kept apart. He gives the impression that chloroform is a substance almost inert towards ferments, for which, therefore, some mechanical action on living cells is to be sought. Chloroform is, however, certainly not without action on ferments, and affects some much more than others; the maltase of yeast, for instance, is distinctly affected by it, and it may be that some ferment essential to cell-growth and multiplication is extremely sensitive to it. It is difficult to estimate at all quantitatively from his experiments the sensitiveness of zymase to such antiseptics, on account of the unknown factor of their action on endotryptase. This also applies to the experiments on the action of added alcohol; expt. 425*b* especially suggests that the alcohol has no negligible effect on endotryptase. The experiments with arsenites are interesting, and give food for reflection to physiologists and physicians alike.

The quantitative fermentation of cane sugar in concentrated solution by zymase was attempted, but the yield of CO_2 and alcohol was always less than the calculated amount, and the author considers and discusses several possible explanations of the phenomenon. In this connection he touches on cases of zymo-hydrolysis where incompleteness has been traced to the action of the hydrolytic products, but does not clearly distinguish between a direct paralysing action of one of the products on the enzyme, such as was found by Taumann in the hydrolysis of amygdalin by emulsin, and a slowing down due to mass-action of the products, a consequence of the reversible nature of enzyme-action, and occurring only on the approach of chemical equilibrium in the system on which the enzyme acts. The fermentation residue was examined for cane sugar with a negative result, but not for a reversion sugar. The author, however, hopes to

investigate this question further. In an experiment given later, done with a lower sugar concentration than in the above, the yield of alcohol approaches the calculated amount.

Glycerol is probably not found in the cell-free fermentation, and is considered a product of cell-metabolism, a similar view to that held by Pasteur about ethyl alcohol. May not the production of glycerol and other higher alcohols be equally due to the action of soluble ferments not yet discovered?

The experiments on regeneration of yeast, which conclude part i., serve to show how much work remains to be done in this direction. The whole account of the general research is given in a lucid and interesting manner, and deals with many lesser matters arising out of the main thesis, each point being illustrated by tables of the actual experiments performed, and the results of the experiments are fully discussed. The author establishes himself especially firmly where other investigators have questioned some of his work.

Part ii., by Profs. Hahn and Geret, gives an account of the discovery of endotryptase by the former author, the description of the experimental work being followed by a good summary.

Part iii. is by Prof. Hahn alone, and describes the reducing properties of yeast-juice as shown by experiments performed by himself and Dr. Cathcart. Some reasons are given for the author's thinking that the reducing power is due to the same ferment, zymase, which induces alcoholic fermentation.

Part iv., by Profs. Hans Buchner and Rudolph Rapp, is on the relation of oxygen-supply to the fermenting power of living yeast-cells.

The contradictory results of previous workers are first reviewed, Pasteur's theories being considered and Chudiakow's work repeated and examined critically in detail. The latter had found that air had no effect on the fermenting power, but that it killed yeast-cells more rapidly than hydrogen, when each was drawn through a sugar solution containing a small quantity of the yeast. The authors find that his results were partly due to defects in his aspiration methods, more air than hydrogen being drawn through in a given time, with consequent injury from shaking. They state also that he used a yeast of too little vitality for general conclusions. They find that neither air nor hydrogen, as such, affects the fermenting power, and that the mechanical shaking of the fluid is detrimental if it exceed a certain limit. The effects of air and hydrogen differ only in that the former induces a slight multiplication of the yeast cells, and thus leads to a rather larger production of CO_2.

The authors then pass on to investigate the effect of air on cultures of yeast grown on beer-wort-gelatin with 10 per cent. of glucose. Here, with a free supply of air, they find one part of sugar oxidised to every five parts fermented. The yeast multiplies more rapidly under such conditions than when very little air is supplied, but in the latter case a given weight of yeast ferments more sugar.

The whole volume is full of interest and instruction, and cannot fail to give the greatest pleasure to a student of alcoholic fermentation.

ARTHUR CROFT HILL.

AN INDIAN FLORA.

The Flora of the Presidency of Bombay. Vol. i. Ranunculaceæ to Rubiaceæ. By Theodore Cooke, C.I.E., M.A., M.A.I., LL.D., F.G.S., M.Inst.C.E.I. Pp. 645. (London: Taylor and Francis, 1901–3.) Price 27*s*.

THE labours of botanists and of a small band of foresters, in India and at Kew, have supplied us with rich stores of information as to the Indo-Malayan flora. These rendered possible the issue of Sir Joseph Hooker's monumental "Flora of British India."

But British India and Malaya, including as they do countries far apart, with climates ranging in temperature from low alpine to high torrid extremes, in humidity from the perpetual aridity of the desert to the permanent moistness of the equatorial tropics, exhibit subfloras and kinds of vegetation of corresponding variety. In order to map out these separate floras of British India, including Burma, the Government of India has decided to issue a series of "regional floras." Such a series will be of great service, because the information at present available as to the floras of certain large tracts of India is lamentably deficient. This deficiency Sir George King's inauguration of a botanical survey of India is calculated to remove.

For the preparation of the first of the "regional floras"—that of Bombay Presidency—the Government of India was fortunate enough to secure the services of Dr. T. Cooke.

To write an ideal "flora" of Bombay is at present impossible. For such a work should not only enable persons to identify plants found in the Presidency, but should also give information as to the geographical distribution of the indigenous species, including their general and local distribution, their habitats, and their frequency of occurrence; it should also impart information, often unavailable to the worker in Europe, as to the habits, colours, dates of flowering, of sprouting, and of defoliation. Finally, it should give a general account of the whole flora and vegetation of the region, and map out their subdivisions within that region. The present "flora" does not contain all these desiderata, for it is not yet concluded, and much remains to be discovered in regard to the local distribution and periodicity of the Bombay plants. This, the first volume, includes the whole of the Polypetalæ, following Hooker's sequence of orders, and the natural order Rubiaceæ.

The characters exhibited by the natural orders are given very fully, so much so that an inexperienced person would find it difficult to decide upon the really salient features. This difficulty might be reduced by printing important diagnostic characters in different type. But when the work is finally complete, the author may aid the tyro by giving abbreviated diagnoses, or possibly an analytical key of the natural orders.

In describing genera and species of exotic plants the botanist working in a herbarium is often at a disadvantage. The specimens reaching him are frequently comparatively small, their colours are changed,

and the information supplied by the collector regarding them may be meagre. But Dr. Cooke, with his ripe experience in India, is in a position of vantage. His descriptions of genera and species are clear and vivid, and at times include information on vegetative characters that can be observed only on the spot. It may be suggested, however, that an even more free record of vegetative characters would greatly facilitate the identification of a plant by a person happening to meet with it in blossom but not in fruit, and would supply botanists at a distance with valuable information otherwise inaccessible. To take specific examples. The two indigenous lythraceous genera with indefinite stamens, Lagerstrœmia and Sonneratia, are distinguished from one another in the analytical key by their fruits; yet their habits and habitats are sufficiently dissimilar to be of immediate use in an analytical key, but we are not told in the present work whether or no *Sonneratia apetala* possesses the erect respiratory roots so characteristic of *S. acida*. Again, in the Rhizophoraceæ, the four genera of the saline swamps and littoral situations are at once separable from the inland Carallia by their habitats, apart from the seeds, which are used as the basis of distinction in the analytical key. Furthermore, species of Rhizophora emit aërial roots from their epigeous branches, and thus stand apart from other rhizophoraceous plants, and, indeed, so far as I know, from all mangrove plants except *Acanthus ilicifolius*. Surely the mention of these roots would greatly facilitate recognition of species of Rhizophora, yet no mention is made of them; and if, as is quite conceivable, these species are apt not to possess them in Bombay Presidency, information to this effect would be of extreme interest to botanists. Whilst discussing vegetative characters, it may be remarked that the "white spongy bodies" in the shoots of *Jussiaea repens* are adventitious roots, not stipules. And the generally accepted view in regard to the leaves of Rubia is that they are stipulate, but that the stipules are often leaf-like in form.

Dr. Cooke's analytical keys of genera and species are, it need hardly be stated, admirable examples of the approved form, and he may be wise in adhering to the system that experience has shown to be most useful, even though it frequently assumes that a person using the "flora" possesses shoots, flowers and fruits of the specimen he desires to identify.

The attractive and clear detailed descriptions of the species are succeeded in most cases by mention of the times of flowering. In many instances there is no record as to whether a plant described is deciduous or evergreen. Records on this point, coupled with additional information as to the times of opening of floral and vegetative buds, and of the shedding of the leaves, would throw much light upon the scarcely touched subject of the periodicity of plant-life in the tropics. As this subject has, in addition, considerable practical economic significance, it is to be hoped that authors of the Indian "regional floras" will record such of these data as are known, and will thereby stimulate further observation.

On the question of geographical distribution, facts are given as to the occurrence of the indigenous species in places outside the Presidency, and many details are added concerning their frequency of occurrence, localities and habitats, within the Presidency. But the author specially directs attention to the need for information on the local distribution of species. Despite of this lack of complete information, the hope may be expressed that Dr. Cooke will include in his work some account of the floristic subdivisions of the Presidency dealt with, and that the authors of other Indian "regional floras" will do likewise. Of equal scientific interest, and probably of greater practical importance, would be an account of the distribution of types of vegetation, or plant-formations, within the area. Such an account of the distribution of types of vegetation within Bombay Presidency would be of especial botanical interest, for

"the rainfall varies . . . from 3 or 4 inches, or even less in the almost rainless districts of Sind, to upwards of 300 inches on the Western Ghâts."

The vegetation shows corresponding diversity, varying from arid or rocky desert-tracts to moisture-laden evergreen forests. As to the practical aspect, we now recognise that vegetation reflects in its form the environment, and that plants, when their actions are interpreted aright, are more cunning analysts of external conditions, including soil and climate, than are the most accomplished chemists and meteorologists.

Brief references to the economic uses of many of the species described, and vernacular names, add value to the book before us.

In conclusion, Dr. Cooke is to be congratulated on producing a most excellent work.

PERCY GROOM.

THE STUDY OF FERMENTATION.

Fermentation Organisms, a Laboratory Handbook. By Alb. Klocker. Translated from the German by G. E. Allan, B.Sc., and J. H. Millar, F.I.C. Pp. xx+392. (London: Longmans and Co., 1903.) Price 12s. net.

THE importance of a systematic study of the micro-organisms which play a part in the various processes of fermentation is making itself felt more and more as time goes on and new facts and phenomena are brought to light. The old empirical methods of twenty years ago have passed away before the marvellous changes first introduced by Hansen, and the culture of yeast is recognised as one of the secrets of success in the manufacture of the various kinds of beer. The study has long been carried on under the personal supervision of Hansen and his assistants, but until recently has been almost entirely conducted under some form of personal supervision. As in other cases, however, the study has outgrown so limited a method of teaching, and we have in this volume a laboratory handbook which will enable practical work in the culture of fermentation organisms to be more widely spread, and probably more successfully conducted, than has hitherto been the case. The volume is welcome on this account especially, but it has other claims also on the student, coming as it does from the

Carlsberg laboratory, and embodying the ideas and teaching of Hansen himself. It is welcome also to English readers from the fact that it has been translated in great part by one of the disciples of the Burton-on-Trent school, from which have come so many valuable contributions to our knowledge of the chemistry of the carbohydrates concerned in brewing.

The author has described at great length what we may consider to be an ideal laboratory for the practical study of the lower fungi, including, indeed, the pathological bacteria, though these are not necessarily included in the range of study he sets forth. His description is greatly to be commended, for he is not satisfied with saying what apparatus should be provided and what precautions observed in arranging the laboratory, but he gives a careful explanation of the reasons underlying his plans, so that mere empirical work has no place in this course. The descriptions of apparatus are good, showing what are the best forms of the modern appliances now at the disposal of workers at the subject. Perhaps a little less detail would have sufficed in the section upon the microscope, as the instrument has now so widespread an application in so many branches of science. Workers will welcome especially the instructions given in the methods of culture of micro-organisms, from the original methods of water culture of Hansen to the modern plate cultures, in which gelatin and similar media take so large a part.

A very important section of the work is devoted to the biological analysis of yeasts, and the methods of ensuring pure cultures. Also to the biological analysis of water, air, and soil.

In the later portion of the volume the author treats in some detail of the fermentation organisms themselves. In this section the Saccharomycetes occupy the largest place, as is natural when we consider the fermentations in which they play a part. Mucor and its allies, however, are not neglected, and fair attention is given to the ascomycetous moulds. Their diagnostic features are described, and the part they play in various fermentations is discussed, the idea being kept prominently in view that the author is writing as a teacher for students, and that the work is a laboratory handbook. Finally, the bacteria come in for recognition.

The book will be welcomed further for the very admirable historical sketch of the gradual development of our knowledge of fermentation from the earliest times. It is very satisfactory to find that this section contains an admirable summary of the work of Hansen himself.

The volume concludes with a very complete bibliography.

OUR BOOK SHELF.

Five Figure Logarithmic and other Tables. By Alex. M'Aulay, M.A. Pp. xl + 161. (London: Macmillan and Co., Ltd., 1903.) Price 2s. 6d.

Siebenstellige Logarithmen und Antilogarithmen. By O. Dietrichkeit. Pp. 64. (Berlin: Julius Springer, 1903.) Price 3 marks.

THE book by Mr. M'Aulay is of a very handy size, specially adapted for the pocket. The author, in the preliminary pages, explains the general properties of logarithms and the use of the tables which follow. The tables themselves comprise, first, an ordinary four-figure table of logarithms of numbers, occupying two pages, and without the usual antilogarithms. Next, a five-figure table of logarithms of numbers from 0 to 100,000, with a complete set of proportional parts or differences; these take up thirty-six pages. Then comes the second principal table of the book, giving the logarithmic sines, cosines, tangents, and cotangents of angles for each minute, with differences for intervals of ten seconds. Some subsidiary tables and useful numbers follow, very much condensed, so as not materially to add to the size of the book.

The tables would be improved if they could be provided with a marginal or thumb index to facilitate reference. The two main tables are printed in clear bold type, and the little volume will prove extremely useful to all who require greater accuracy than is given by four-figure mathematical tables.

The tables of Herr O. Dietrichkeit are most ingeniously arranged. The numbers in the columns are given to seven figures, the last two of which are written as suffixes in smaller type. The logarithm or anti-logarithm of any four-figure number can be read directly from the tables to any desired accuracy up to seven figures without requiring differences to be used. The two tables of logs and anti-logs are printed on paper of different tints, a very good feature, and they occupy only eighteen and twenty pages respectively. They are provided with a complete thumb index, reading both backwards and forwards, and it will be found that readings may be taken from the tables almost, if not quite, as quickly as from the well-known four-figure tables.

If five-figure accuracy were required for five-figure numbers, the difference for the fifth figure would have to be calculated. And it is possible from these tables, although occupying only a few pages, to obtain seven-figure accuracy for seven-figure numbers, by means of an interpolation constant and a most ingenious method of calculation, which, however, would be too long except for occasional use. The tables will prove most valuable in cases where, though four-figure accuracy is usually sufficient, it is desired to have at command a means of greater accuracy for special purposes. The volume is beautifully got up and printed, and it is quite a pleasure to use the tables.

Économie rurale. By E. Jouzier (Encyclopedie agricole). Pp. xv+476. (Paris: Baillière et Fils, 1903.) Price 5 francs.

THIS book belongs to a type of which we have few representatives in this country; it consists of a discussion of such general principles of political economy as may be illustrated in the conduct of a farm.

Beginning with an account of the relations of agriculture to the State, questions of taxation, transport and markets, it proceeds to discuss the capital required in the business of agriculture, the live and dead stock, insurance, depreciation, and the valuation of such contingencies as cultivations and manurial residues. Such general principles as the minimum of production necessary to profit and the law of diminishing returns are explained and illustrated. Questions of labour, methods of finding the cost and profit or loss of the different operations are considered; finally, tenure, compensation for improvements, systems of land holding, cooperation, and similar matters touching on the economics of agricultural production are dealt with. The whole is treated in a somewhat abstract and generalised fashion, and would find little favour with the practical farmer or landowner here; we can, however, commend the book to teachers of agriculture as suggestive and likely to lead to a wider outlook than generally prevails in the treatment of similar questions in this country.

A Naturalist's Calendar, kept at Swaffham Bulbeck, Cambridgeshire, by Leonard Blomefield (formerly Jenyns). Edited by F. Darwin. Pp. xix + 85. (Cambridge: University Press, 1903.)

IN his introduction the editor has given several reasons (all of them excellent in their way) for the reissue of this excellent memorial of an exceedingly accurate and gifted naturalist. He has apparently omitted, however, that which, in our opinion, is the most important argument of all, namely, the relatively early date (previous to 1846) at which the record was kept. This renders it extremely valuable for comparison with observations of a similar nature made at the present day, for the purpose of ascertaining whether any secular changes in the date of the arrival of migratory birds or in the flowering of plants has taken place in this country since the compilation of this calendar. Whether any such differences do occur would require very careful comparison, but we should not be surprised to learn that the average date of the cuckoo's arrival has altered somewhat since Blomefield's time. Be this as it may, the well-known scrupulous accuracy of its compiler renders his calendar of nature a record of exceptional value and interest, belonging to a period when such compilations were rare. There is, therefore, every justification for its republication in the present convenient form, and its appearance at a morphological centre like Cambridge may certainly be regarded as a good augury for the future of natural history studies.

Mr. Darwin gives several anecdotes of the author, to which the present writer can add another. Mr. Jenyns (as he was then called), who was by no means a handsome man, was in early life accustomed to preach occasionally in a church attended by the Henslow family. After one of these periodical visits, the younger members of the family were asked why they were always so unusually quiet in church when Uncle Leonard preached. To which query came the reply that "he kept on making such ugly faces."

R. L.

Elements of Physics, Experimental and Descriptive. By Amos T. Fisher, B.Sc., assisted by Melvin J. Patterson, B.Sc. Pp. 184. (London: D. C. Heath and Co., 1903.) Price 2*s.* 6*d.*

THOSE of us who are engaged in university teaching are personally interested also in the kind of science teaching which is given in schools. Lads come to college fresh from school crammed with what is called physics; but, owing to its unsatisfactory character, our first effort is usually to knock out of them the loose and erroneous knowledge with which they have been crammed. We are afraid that the book under review is not likely to improve matters. A long list of errors which we have noted down lies before us—far too long to reproduce here—and we must be content with a few as a sample.

The diagrams of lines of magnetic force of currents (p. 131), of the dispersion in a prism (p. 96), of the formation of a rainbow (p. 98), are all wrong. It is incorrect to state that the image of (*sic*) a concave lens is always smaller than the object, and that a concave meniscus is a converging lens. The field of a magnet does not vary as the inverse square of the distance. An induced charge is not usually equal to the inducing charge. . . .

A paint-brush illustration of the production of induced currents (p. 137) gives the wrong direction to the current. The conservation of energy is stated to be a consequence of the conservation of mass!

In spite of numerous errors and fallacies, and weaknesses of description, the book is not wholly bad; but what a burden is thrown upon the teacher who has to put all these wrong things right! For the private student the book cannot be recommended.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

An Earthquake Shock at Kimberley.

LOCAL earthquakes are rare phenomena here. There was, however, a small shock at 8h. 43m. p.m. (G.M.T.) on Friday last, July 31. It was accompanied by the loud rumbling noise resembling the passing of a heavy waggon, and caused some shaking of furniture. It appears to have been felt and heard over a considerable area. The record by my large horizontal pendulum showed a single nearly sudden dip to the west of 3·6mm. (*i.e.* from 30·4mm. to 34·0mm., measured from the reference base-line), roughly corresponding to a tilt of about 3″, and a rather more gradual recovery, with very little (if any) return swing to the east. No certain signs of preliminary tremors could be detected upon the record. It seems important (*cf.* Milne, "Earthquakes," p. 309, 4th ed., 1898) that for some days previously there had been a gradual, general dip of the level to the east, the mean distances of the hourly readings from the reference base-line, measured from east to west, being:—

July 27	34·3 mm.
„ 28	34·0 „
„ 29	31·1 „
„ 30	27·0 „
„ 31	28·1 „
Aug. 1	29·0 „

The weather during the week had been moderately warm and cloudy, but, so far as I know, there was not any rain anywhere on the table-land. There was no disturbance of the barometer accompanying the shock.

I enclose a cutting from the *Diamond Fields Advertiser* of August 3. It gives the duration at Koffyfontein as three minutes, which probably really means that some loose articles of furniture might have remained swinging for some time after the shock had passed. Koffyfontein, however, like Kimberley, is a diamond mining centre, and from various reports it seems to be demonstrated that the earth-movement was much more pronounced in the vicinity of the open workings than elsewhere.

J. R. SUTTON.

Kenilworth, Kimberley, S. Africa, August 3.

Sun-spots and Phenology.

IT can be shown in several ways, I think, that we have, on the whole, in these parts (London), more warmth when the sun-spots are numerous than when they are few, a state of things rather opposite to that in the tropics, where (according to M. Nordmann, who has lately confirmed the work of Dr. Köppen some thirty years ago) sun-spots mean coolness, and there is most warmth about minima.

The recurring contrast, in the case of Greenwich, appears to be most distinct in the early part of the year. Thus we may show it by taking the mean temperature of February and March, and smoothing the curve with averages of five (curve A in diagram). B is the sun-spot curve. Thus about sun-spot maxima, the milder weather of spring seems to set in, on an average, *earlier* than at other times. It might be expected that this would have an influence on the data of phenology (time of flowering of plants, &c.), and in many cases we find it is so, that is, curves which represent the dates of flowering of plants will be found to show a certain agreement with the temperature curve of February-March, and with the sun-spot curve.

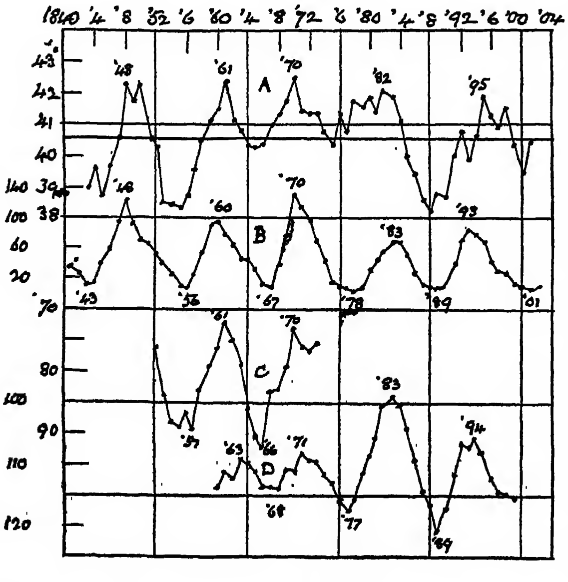
In the diagram are given two of these phenological curves (C and D). C is that for flowering of *Ribes sanguineum* in Edinburgh (1850–87), and D that for flowering of *Azalea pontica* at Parc de Baleine, Allier, in the heart of France (1858–1901). (The scales are separate.)

The date of flowering is given as the day-number in the year, and these numbers are smoothed with averages of

five. The curves are inverted, so that high points represent early dates and low points late dates.

Other examples might be given. This line of inquiry has been followed to some extent by M. Flammarion in France, and it seems desirable that attention should be given to it in this country by those interested in phenology.

The contrast above referred to between the relations of sun-spots and temperature in western Europe and those



in the tropics also calls for elucidation. Probably no meteorologist would now regard it (or other such contrasts) as fatal to the idea of sun-spot influence.

ALEX. B. MACDOWALL.

Retarded Motion of the Great Red Spot on Jupiter.

PERHAPS the most notable fact brought to light by observations of Jupiter during the present season is that the velocity of the great red spot has been again retarded. The rotation period of this well-known object has been as follows in recent years:—

	h.	m.	s.
1898	9	55	41·8
1899	9	55	41·9
1900	9	55	41·7
1901	9	55	40·9
1902 and to May 1903	9	55	39·0
May 26 to August 21, 1903	9	55	41·5

At the end of May last the longitude of the spot was about 30°, whereas at the present time it is 32°, indicating an easterly drift of 2°, whereas during the preceding twelve months the marking had shown a westerly drift of about 1° per month. The spot now follows the zero meridian (system ii. of Mr. Crommelin's ephemeris, *Monthly Notices* R.A.S., lxiii. p. 110, December, 1902) by about 53 minutes. A remarkable disturbance has recently occurred in the southern equatorial belt of Jupiter. In about longitude 140° to 175° (system i.) several nearly black spots have appeared, and the belt in this region is much torn and full of irregularities, changing from night to night, and evidently subject to extensive commotions.

W. F. DENNING.

The Spots on Saturn.

DURING the past two months about 75 transit times of these objects have been taken here. Several of the more conspicuous markings are moving slower than expected, and their positions appear to be well represented by a rotation period of about 10h. 39½m.

W. F. DENNING.

Bishopston, Bristol, August 25.

THE SOUTHPORT MEETING OF THE BRITISH ASSOCIATION.

SINCE the prospective programmes of the various sections of the British Association were obtained for last week's NATURE, the following additional particulars referring to the subsection of Section A, devoted to astronomy and meteorology, and the International Meteorological Committee have been received from Dr. W. N. Shaw, chairman of the subsection.

It is intended that the subsection shall meet on Friday, September 11, and on the following Monday and Wednesday. The proceedings may be expected to be especially interesting on account of the presence of a number of distinguished meteorologists from foreign countries who will be in Southport in connection with the meeting of the International Committee. It is hoped that arrangements can be made to enable the members of the committee to take part in the meetings of the subsection, although separate meetings of the committee must be held for the transaction of business.

The questions already proposed for discussion by the Committee include the initiation of international cooperation in connection with atmospheric electricity and solar physics, and its extension as regards terrestrial magnetism; the revision of the arrangements for the exchange of daily telegraphic reports, and the modification of some of the existing international conventions with regard to the observations made at stations of various orders and the method of recording them.

In the subsection on September 11, after an address by the chairman on methods of meteorological investigation, the president of the Association, Sir N. Lockyer, will read a paper on the correlation of solar and terrestrial phenomena, which will be followed by a discussion, as a preliminary to a proposal for putting the organisation of work in connection with that subject upon an international basis. Dr. Buchan will contribute a communication illustrating the distribution of rainfall in Scotland according to the succession of years of the sun-spot cycle. At the same session it is hoped that some of the members of the International Meteorological Committee who have taken a prominent part in the prosecution of researches in connection with that committee may be able to contribute papers. In particular the work of the committee on cloud observations has recently been brought to a conclusion, and a summary of the final results achieved would be very acceptable.

For any further available time on that or the other days there is already a substantial programme. Various astronomical papers have been referred to in the previous notice. The committees which have to present reports are those on kite observations, on the Ben Nevis Observatory, and on seismological observations, and any one of them, either of themselves or in connection with papers on special points associated with them, may give rise to valuable discussion. Prof. Hergesell, the chairman of the aëronautical committee, will be able to give the latest information as to the international investigation of the upper air, and Dr. Varley will exhibit the record obtained by him for Mr. P. Y. Alexander with an unmanned balloon that reached the extraordinary height of 70,000 feet on a journey from Bath in July. The kite equipment and method of investigation employed by Mr. Dines will be exhibited, if possible, in action.

Prof. Callendar will speak upon self-recording instruments, and thus open the way for the discussion of a subject which is of pressing importance in cooperative meteorological work.

The exhibition of objects of interest in connection with meteorology, terrestrial magnetism, and allied sciences has already been referred to in the columns of NATURE. Arrangements have been made with the view of exhibiting the formation and physical properties of the remarkable vortex ring of smoke produced by the discharge of a mortar of the same type as those which are extensively used in southern Europe with the object of mitigating hailstorms.

By way of illustration of the method adopted by the Meteorological Council for dealing with telegraphic weather reports, a weather chart for north-western Europe, with remarks and forecasts for the British Isles, will be prepared each morning during the meeting on the receipt of telegraphic information at Southport, and a limited number of lithographed copies will be available in the reception room.

THE OLDER CIVILISATION OF GREECE.[1]

STUDENTS of the older civilisation of Greece, which we usually know as "Mycenæan," will welcome the appearance of the eighth volume of the British School at Athens Annual, which, we are glad to say, this year is printed on much better paper than formerly, and shows a great improvement both in editing and arrangement. The volume contains the chief results of the excavations which were undertaken in Crete in 1902, both by the officers of the British School itself and by the Cretan Exploration Fund, of which Mr. A. J. Evans is the prime mover. More than a third of the book is occupied by an elaborate paper by Mr. Evans, who continues his annual description of the results of his excavations at Knossos; this is profusely illustrated by no less than seventy-four reproductions from photographs and line drawings, a map showing the state of the excavations at the present time, and two plates. Mr. Evans's paper is exceedingly interesting reading, and his discoveries appear to have been, as is usually the case, of first-class importance; we earnestly hope that good fortune may attend his labours in the future at Knossos as it has done in the past! It is, however, obvious that, for extensive excavations of this kind, which involve heavy and prolonged expenditure, increased funds are necessary. It is well known that Mr. Evans has contributed to the expenses of the work from his own private means far more than was right, but it is clear that no archæologist, however enthusiastic he may be, can continue to spend his own money indefinitely on researches which would, in any other country but England, be undertaken either by the Government or by some wealthy academy.

The most important objects described by Mr. Evans are:—(1) A series of tablets of porcelain mosaic representing houses and towers, which are curiously like children's dolls' houses, with a door in the middle and the windows divided by mullions. (2) A series of similar porcelain tablets with representations of warriors and animals. (3) A set of terra-cotta models of pillar-altars, with figures of doves perched upon the top of them. (4) Fragments of ivory figures of leaping youths, with the hair represented by bronze spirals let into the ivory. (5) A small shrine discovered *in situ* in the southern part of the palace. The shrine and its contents have been carefully kept in their original position, and a small house has been built over them to protect them from the weather. The contents consist of rude iconic figures of deities, and a horned altar, which is somewhat Canaanitish in type. These horned altars are familiar objects in Cretan diggings, and they are usually described by Mr. Evans as "horns of consecration." (6) Objects inscribed in ink with Cretan hieroglyphics. These are of great importance, for they show that the Cretans employed the Egyptian means of writing as well as the Mesopotamian; they used both pen and ink as well as clay tablet and stylus. (7) The sanitary arrangements of the palace, which appear to have been extraordinarily modern in character. The latrines were water-closets, which were provided with carefully constructed drains made of terra-cotta pipes, the sections of which remind one (see Fig. 7, p. 13) of a sanitary engineer's catalogue of the present day. The exigencies of space will not allow us to enumerate the minor discoveries, and we refer the reader to the Annual itself for a full account of them.

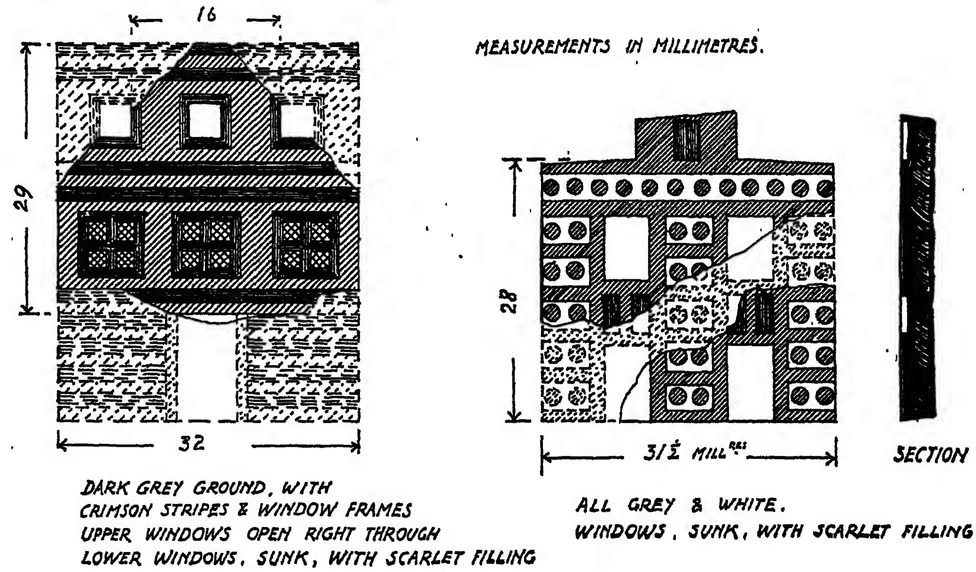


FIG. 1.—Porcelain Tablets in Form of Houses (slightly enlarged).

Mr. Evans ends his paper with some speculations as to the possible connection of Crete with Egypt as early as the time of the fourth and fifth dynasties, *i.e.* about B.C. 3700–B.C. 3200, and it is of interest to note that Mr. H. R. Hall, of the British Museum, publishes in this volume of the Annual a paper dealing more or less with this very subject. Mr. Hall traces the history of the connection between Egypt and the peoples of the Ægean, and the southern coast

[1] "The Annual of the British School at Athens." No. viii. Session 1901–1902. Pp. 348, 20 plates, and many illustrations. (London: Macmillan and Co., Ltd.)

of Asia Minor, from the periods of the sixth and twelfth dynasties down to the reign of Rameses III., *i.e.* for a space of more than 2000 years. The great value of his paper to Greek archæologists consists in the fact that he derives his materials from the Egyptian monuments alone, and he has shown pretty conclusively from the Egyptian records that the Mycenæans, or "Minoans," of Crete were in close communication with Egypt as early as the time of the eighteenth dynasty, about B.C. 1650 to B.C. 1400, and probably much earlier. We may note in passing a point of interest, namely, his identification of the true name of the Island of Cyprus in the time of Thothmes III., viz. Yantanay, which is undoubtedly the same as the Assyrian name for the island, "Yatnana." Mr. Hall also gives new material to the student of Mycenæan art in his identifications of Cretan vases among the tribute depicted on the walls of the tombs at Thebes, about B.C. 1550. The rest of his paper is occupied with an account of the relations of the Egyptians with the Mediterranean tribes who successively invaded Egypt under the nineteenth and twentieth dynasties. He proves that the period of peaceful relations between Crete and Egypt under the eighteenth dynasty was the period of the Minoan civilisation of Knossos and Phæstus, and that the post-Minoan, or true Mycenæan, period in Greece was the time when the peaceful relations of Cretan civilisation with Egypt had come to an end, and, in the author's words, "in the days of the degenerate Ramessids of Egypt, its place had been taken by wandering tribes, amid whose internecine struggles the older civilisation of Greece slowly degenerated and finally passed away.

FIG. 2.—Upper Part and Head of a Model of an Ape found at Mycenæ.

The excavations which have been carried on by the British School itself at Palaikastro, at the eastern end of Crete, are described by Mr. R. C. Bosanquet, the present director of the school. He has found there the remains of a palace and houses, some remarkable interments in painted terra-cotta coffins, and a great quantity of pottery of the pre-Mycenæan or Kamares type. We understand that Mr. Bosanquet's excavations this year have been even more productive than those of last year, and his exploration of the Eteokretan country has given us much new information about this remote but interesting portion of the island. Two or three years ago Mr. Bosanquet discovered on the site of Præsus, the ancient capital of the Eteokretans, another example of an inscription in the non-Greek language of eastern Crete. This is critically examined by Mr. R. S. Conway in this number of the Annual, but we think that his attempt to prove that the language is Indo-European is unsuccessful. Kretschmer has shown that the languages of southern Asia Minor, of which Lycian is the best known example, were not Indo-European, and legend connects the Eteokretans with Lycia. Of the Lycian language Mr. Conway naïvely admits (p. 156, note 2) that he has no knowledge, but yet criticises Kretschmer! The remaining article in the volume, which is by Mr. Marcus N. Tod, is of interest to classical scholars only. The above remarks are sufficient to indicate the interest and importance of the new volume of the British School at Athens.

THE MARQUIS OF SALISBURY.

THE death of Lord Salisbury has robbed us of a great statesman. He had been ill for some weeks and the peaceful end came during the evening of Saturday last. At the beginning of June of this year an attack of nephritis, complicated with a weakness of the heart, set in, and from this illness Lord Salisbury never recovered. Since the preceding Wednesday, when his heart began to fail, it was generally known that there was no hope, and the quiet, painless passing came as a fitting conclusion to a distinguished career, marked always as it was by a dignified reserve and an unusual love for seclusion.

Born in Hatfield on February 3, 1830, Lord Salisbury died in his seventy-fourth year. He was the direct lineal descendant of the great Lord Burleigh, and was educated at Eton and Christ Church, Oxford, where he graduated in 1850. The few years following his stay at Oxford were spent in travel, and included a somewhat prolonged visit to Australia and New Zealand. During this period he learnt from personal experience the dangers and charms of life at cattle stations and at the gold diggings. Returning in 1853, he was elected to an All Souls Fellowship, but as subsequent events showed he preferred the activity of politics to the quietude of university life. In the autumn of the same year he entered the House of Commons as Conservative member for Stamford, and for fifteen years he continued to represent this constituency, until, in 1868, on the death of his father, he took his seat in the House of Lords as Marquis of Salisbury.

It is unnecessary, even if it were appropriate, to give in these columns an account of the numerous incidents in the political career of this renowned statesman. The barest catalogue of the important offices of State occupied by him with consummate ability serves adequately to indicate how intimately his life has been intertwined with the history of the Empire during the latter half of the nineteenth century, and how large a part the dead statesman has taken in the government of the nation. He was twice Secretary for India and President of the Indian Council. In 1876 he was special Ambassador to the historic conference at Constantinople; and in 1878 Plenipotentiary at the celebrated Berlin Conference. Four times he was the Secretary of State for Foreign Affairs, and in this capacity more than any other, perhaps, he inspired the complete confidence of his countrymen. In 1886 he was First Lord of the Treasury, and three times he was called upon by his Sovereign to form a Cabinet. His premierships lasted respectively from 1885–6, 1886–1892, and 1895–1902.

But an account of Lord Salisbury's political career gives no proper idea of the versatility of his genius. When a member of the House of Commons he was actively engaged in journalistic work, and his contributions to the *Saturday Review*, the *Quarterly Review*, and other papers would have secured for a less gifted person a sufficiently high reputation. To men of science, however, the most interesting recollection in connection with Lord Salisbury is the fact that in 1894 he was President of the British Association, and that throughout his political triumphs his great pleasure was, in his leisure hours at Hatfield, to pursue scientific researches in physics and chemistry.

In commenting on the Presidential Address delivered by Lord Salisbury at Oxford in our issue for August 9, 1894, we remarked:—"Many of those who know Lord Salisbury only as a politician and as Minister for Foreign Affairs will be surprised at the wide range of thought and reading displayed in his

handling of the diverse topics which he passes under review." And though Lord Salisbury himself said in that address, "In presence of the high priests of science I am only a layman, and all the skill of all the chemists the Association contains will not transmute a layman into any more precious kind of metal," yet on that occasion he proceeded to give in a masterly fashion "a survey not of our science but of our ignorance." The references to the want of knowledge of the nature of the capricious differences which separate the atoms from each other; the description of the ether as "a half-discovered entity"; the explanation of the deep obscurity which at the time of the address still enveloped the origin of the infinite variety of life, and the impossibility of demonstrating the process of natural selection in detail, combined to make the Oxford British Association address comparable in importance with the great controversy at the same city when the Association met there thirty-four years previously.

The study of science was for many years the solace which Lord Salisbury sought from the cares of State, and it is far from fanciful to suppose that these investigations influenced his political outlook and contributed to his success in meeting the difficulties of government. But whether this is so or not, there can be no doubt that Lord Salisbury's acquaintance with physical and chemical science was of an intimate nature, and added greatly to the joy and comfort of the short years of his retirement.

Lord Salisbury held many other appointments and received numerous academic distinctions. Among these may be mentioned that from 1869 to the time of his death he was Chancellor of the University of Oxford, and his interest in higher education was also shown by the fact of his being a member of the Council of King's College, London. He was a Doctor of Civil Law of Oxford, and a Doctor of Laws of Cambridge University, as well as a Fellow of the Royal Society.

This brief notice of a great career may be fittingly closed with a paragraph from Dr. Traill's monograph. "Lord Salisbury's record is that of an English statesman who, while directing the affairs of his country abroad with singular skill and judgment, has also guided its domestic policy in the paths of wisdom and equity, and, though loyally submitting to the 'will of the majority' in all things lawful, has held it his first duty to maintain the just rights of every class, however small a minority it may constitute, in the State."

PROF. LUIGI CREMONA.

AN interesting account of the life and work of the late Prof. Cremona, by Prof. Blaserna, appears in the *Proceedings* of the Royal Society of Edinburgh (vol. xxiv.), an advance copy of which has been received. By permission of the general secretary of the Society, we print a free translation of Prof. Blaserna's contribution and extracts from a note appended to it.

Prof. Luigi Cremona was born at Pavia on December 7, 1830, and studied there until the year 1848, when he suspended his academic work to join the ranks of the Italian volunteers, and to take part in the heroic defence of Venice until the capitulation of that famous town. He then graduated in mathematics at Pavia, where he had among his teachers Francesco Brioschi, and among his fellow-students Eugenio Beltrami and Felice Casarati. Thereafter he taught in the Gymnasium at Cremona and in the Beccarian Lyceum at Milan.

In 1860 he was appointed to the new chair of higher geometry in the University of Bologna, then reorganised by the Italian Government, and thence he passed, in 1866, to the Polytechnic at Milan. When, after the year 1870, the Italian Government undertook the organisation of the great University of Rome, with its annexed engineering school, Cremona was called, in 1873, to be professor of higher geometry in the university and director of the engineering school, which he reconstructed and established in the old Convent of St. Pietro in Vincoli. The duties of this double post he discharged with fidelity and distinction to the last years of his life.

Although Cremona had been a pupil of Brioschi, an eminent analyst, his predilection was always for geometry, in which he may be said to have created a classical school. His numerous publications refer chiefly to the theory of algebraic curves and surfaces. All the problems that arose in this department of mathematics between 1860 and 1880 attracted his attention, and everywhere he left an indelible trace of the depth and the clearness which characterised his genius.

To general theory are dedicated the "Introduction to a Geometrical Theory of Plane Curves" (1862) and "Preliminaries to a Theory of Surfaces" (1866), two monographs in which he expounds, with originality of view and wonderful unity of method, results partly known and partly new. He demonstrated the fruitfulness of the theorems contained in the second of these memoirs by applying them to the study of surfaces of the third order, in the "Mémoire de Géometrie pure sur les Surfaces du troisième Ordre," which gained in 1886 the Steiner prize of the Academy of Berlin, and which will remain for all time a classic model of geometric research.

But the originality of Cremona appears still more distinctly in his study of the transformations to which his name is now attached. Already in the first half of the nineteenth century a theory had arisen of the projective transformations which change the points and straight lines of one plane into the points and straight lines of another plane, and side by side with these had also been examined the correspondences which transform straight lines into circles or conics. But the idea of treating from a more general point of view the transformations which change straight lines into algebraic curves of any order n whatever belongs to Cremona, who established the basis of this theory in two memoirs (1863–65), and afterwards extended it to space of three dimensions (1871–72), thus opening to geometers a vast field of research, which has not been exhausted at the present day.

While, by these works, of which I have mentioned only the most extensive, and by his splendid lectures, Cremona was firing the rising generation with the love of pure science, and thus exercising a great influence on original geometric research in Italy during the last thirty years, on the other hand he was never weary of showing his interest in the technical applications of mathematics. His little work on "Reciprocal Figures in Graphical Statics" is a beautiful example of this interpenetration of pure and applied science, an interpenetration which characterises another side of his broad genius. Always pursuing this order of ideas, he took assiduous care with his engineering students in Rome to keep science and practice side by side, inciting them to attain that just balance of different faculties of which he gave himself so fine an example.

Besides all this, Luigi Cremona was a statesman. Nominated a Senator of the kingdom in 1879, he took an active part in all the work of the Senate. He was, indeed, one of the most respected and influential of the

Senators, and his reports and speeches reveal a man of frankly liberal views and of firm and stable character He was, for a short time, Minister of Public Instruction in one of the ministries of the Marchese di Rudini.

The fame of Luigi Cremona is world-wide. Almost all the foreign academies elected him a fellow. His death (which happened on June 10 last) has been a loss not only for Italy, but for science universal, in which his discoveries will long secure him a place of honour.

In the course of a note appended to Prof. Blaserna's valuable statement of facts as to Cremona's career, Prof. Chrystal remarks:—

In the year 1884, Cremona, along with Hermite and his son-in-law Émile Picard, was my guest during the tercentenary festival of the University of Edinburgh. Besides these three distinguished mathematicians, the following were present at the festival:—Helmholtz, Bierens de Haan, Cayley, Sylvester, Lord Kelvin, Stokes, Salmon, Lord Rayleigh, and Tait. The majority of these dined one evening with Lord M'Laren, and it is scarcely probable that there ever was such a feast of mathematicians before or since. Of this brilliant band of nineteenth century men of science, there remain with us now only Kelvin, Rayleigh, and Picard.

NOTES.

THE ninth International Geological Congress was opened at Vienna on Thursday last, when Dr. Tietze, director of the Imperial Institute of Geology, was elected president.

A REUTER telegram from Cape Town states that the Cape Legislative Council has agreed to a motion in favour of addressing a communication to the Imperial Government on the subject of the adoption of the metric system.

ACCORDING to the *Athenaeum*, a resolution was passed at the conclusion of the recent geodetic congress at Amsterdam requesting the various nations to carry out extensive measurements of gravity from the Atlantic towards the east through the lowlands of Europe and Asia, as well as in the plateau around Thibet. A clear conception of the variations of weight and of the distribution of bulk in the crust of the earth would be gained thereby in connection with astronomical determinations of longitude and latitude.

Science states that the commission sent by the U.S. Marine Hospital Service to Vera Cruz reports three propositions as having been demonstrated beyond doubt, namely, (1) that the cause of yellow fever is an animal parasite, and not a vegetable germ or bacterium; (2) that the disease is communicated only by the bite of mosquitoes; (3) that only one genus of mosquitoes, *Stegomyia Fasciata*, is the host of the yellow fever parasite.

THE *British Medical Journal* states that Dr. S. R. Christophers, who was associated with Dr. Stephens in the investigation as to malaria conducted on the west coast of Africa and in the Indian cantonments, has been notified by the Indian Government that the medical authorities desire him to proceed at once to India, with the view of his again taking up special work relating to malarial infection. Dr. Christophers is, it is stated, leaving almost immediately to enter upon his duties.

ACCORDING to a Stockholm correspondent of the *Times*, the Swedish steamer *Frithjof*, which on August 17 started from Stockholm for the relief of Dr. Otto Nordenskjöld's South Polar Expedition, will take on board at Bremerhaven provisions for three years and wireless telegraphy apparatus. Such apparatus is also, it is stated, to be fitted on board the Argentine gunboat *Uruguay*, and it is thought that this vessel, which is iron built, will remain outside the ice while the *Frithjof* will push on as far south as possible. From Bremerhaven the *Frithjof* will go to Plymouth to coal, and then *viâ* Madeira to Buenos Ayres, where possibly an Argentine naval officer will join her. She will then go to Punta Arenas, whence her commander proposes to reach Snowhill, the supposed winter station of the Antarctic.

ON Saturday last the Canadian Government steamer *Neptune* sailed from Halifax, Nova Scotia, for Hudson Bay and Arctic waters on an expedition to last a year and a half. The object of the expedition is to conduct, on behalf of the Government, a botanical, geological, and natural history investigation. The party will take formal possession of the Arctic Islands and the shore of Baffin's Bay. The commander of the expedition will report on the alleged extensive American poaching in the Hudson Bay fisheries. The importance of the cod and halibut fisheries will be reported on.

A MESSAGE from Naples, dated August 22, states that the explosions of Mount Vesuvius are increasing in violence, and quantities of volcanic matter have been thrown to a height of about 200 yards. At half past 6 o'clock of the morning referred to, a slight earthquake shock was felt.

THE arrangements for the eighth International Geographical Congress, to be held next year at Washington, are, says the *Times*, taking shape under the care of a committee representing the ten geographical societies and mountaineering clubs of the United States, which have united to welcome the geographers of all nations to American soil. The congress will meet in Washington on September 8, 1904, and will hold daily sessions on September 9, 10, 12, 13, and 14. The subjects for treatment and discussion during the meeting at Washington are classified under the following heads:—(1) Physical geography, including geomorphology, meteorology, hydrology, &c.; (2) mathematical geography, including geodesy and geophysics; (3) biogeography, including botany and zoology in their geographical aspects; (4) anthropogeography, including ethnology; (5) descriptive geography, including explorations and surveys; (6) geographical technology, including cartography, bibliography, orthography of place-names, &c.; (7) commercial and industrial geography; (8) history of geography; (9) geographical education. The committee urges that early notice be given by those desirous of presenting communications or proposing subjects for discussion, July 1, 1904, being fixed as the latest date for submitting communications designed for printing in connection with the congress, and August 1 in the case of abstracts (not exceeding 1000 words in length) designed for insertion in the daily bulletin.

AN International Electrical Congress will be held at St. Louis, Mo., from September 12 to 17 of next year. The sections which have been proposed for the main body of the congress are:—*General Theory*.—Section A, mathematical and experimental. *Applications*.—Section B, general applications; Section C, electrochemistry; Section D, electric power transmission; Section E, electric light and distribution; Section F, electric transportation; Section G, electric communication; Section H, electrotherapeutics. Prof. Elihu Thomson has been elected president of the committee of organisation, and the general secretary is Dr. A. E. Kennelly, Harvard University, Cambridge, Mass.

THE *Times* Brussels correspondent states that the eleventh International Health Conference will be held in Brussels from September 2 to 8. One of the leading questions for discussion is whether the tuberculosis bacillus in the domestic animal is identical with that of the human species.

IN connection with an exhibition which is to take place at Milan in 1905, a national sanitary congress is to be held. The work of the congress will be dealt with in the following sections:—sanitary assistance, public hygiene, clinico-scientific and therapeutic, medical jurisprudence and accidents to workmen, professional interests.

A GENERAL exhibition arranged by the Central Association of Inventors, of Bayreuth, for the purpose of facilitating the sale of patents and copyrighted patterns is to be held during September and October next at Nuremberg. There are, it is stated, more than 200,000 copyrighted patterns in Germany and more than 140,000 patents, but one-half of these are not in public use, the reason being that the inventors are not able to exploit their inventions. It was because of this that the Central Association came into being some years ago. Its purpose is to assist the members to make their inventions profitable to themselves, the majority of inventors not having the means to do so. The Association furnishes space to inventors without means free of cost, and charges no fees for effecting a sale.

ACCORDING to a Reuter telegram from Berlin, a number of mining officials will, at the instance of the Minister of Commerce, shortly be sent to this country to make a thorough study of the hygienic and sanitary arrangements in mining districts.

THE *Electrician*, quoting from the *Western Electrician* of Chicago, states that preliminary reports have been given concerning wireless telegraph experiments which have been conducted on board the training ships *Prairie* and *Topeka*, in conjunction with shore stations, by the Navy Department of the United States during the last year. The reports state that the Slaby-Arco system is well suited for naval purposes, and has been adopted by the United States Navy. It was tested in competition with French, German, and English devices, not, however, including the Marconi system. Satisfactory terms, it is stated, could not be made with Mr. Marconi for the installation of his instruments on the war ships, and further negotiations were discontinued. Twenty sets of Slaby-Arco instruments have been installed on eight war vessels, which used them in the fleet manœuvres.

A TELEGRAM from New York, through Laffan's agency, states that the advisory board of the American scientific expedition to Babylon has been compelled to abandon its plan of extensive excavations at that place, preparations for which have been made during the last three years. The abandonment is due to the persistent refusal of the Porte to permit the American society to carry on such work, although it has readily authorised excavations by other nations.

THE collections made by Mr. M. J. Nicoll, who accompanied Lord Crawford, as naturalist, in the R.S.Y. *Walhalla* during his recent tour round the world, have arrived at the Natural History Museum, South Kensington, and contain about 1500 specimens. The *Walhalla* remained so short a time at most of the places where she stopped that it was not possible to procure a large number of examples of terrestrial animals; but about 250 bird-skins were brought home. The principal collections were made in the Magellan Straits, at Valparaiso, in the Samoan and Fiji groups of the Pacific, and in Torres Straits. Mr. Nicoll is now engaged in arranging and naming the specimens.

SEVERAL living specimens (three of which have arrived safely) of the wild guinea-pig of Brazil have, according to *Science*, recently been sent to the zoological laboratory of Harvard University by Mr. Adolph Hempel for the purpose of experimental studies in heredity.

DR. CARROLL gives an interesting *résumé* of our knowledge of the mode of transmission of yellow fever (*Journ.* Amer. Med. Assoc., May 23). He points out that the mosquito theory has been proved to be true, and that the non-communicability of the disease from person to person, and by means of fomites, has been demonstrated. Yellow fever has been eradicated from Havana, one of its endemic homes, by the institution of measures directed against the mosquito, after extreme cleanliness and energetic disinfection had proved dismal failures.

THE specificity of anti-venene, the anti-serum for snake venom, has been a matter of controversy for some years. Calmette originally asserted that anti-venene was not specific, that is, cobra anti-venene, prepared by injecting an animal with increasing doses of cobra venom, though most active against cobra venom, would also antagonise other venoms. Martin, and more recently Tidswell, in Australia, questioned the correctness of this view, and Captain Lamb, I.M.S., has now proved beyond doubt that anti-venomous sera are just as specific as any other antisera, *e.g.* diphtheria or tetanus (*Sc. Mem.* of the Gov. of India, New Series, No. 5). He has tested the neutralising properties of several anti-venomous sera towards the venoms of many species of venomous snakes, and in no case was any neutralising power exhibited by a serum except towards the venom with which it had been prepared.

THE annual report issued by the superintendent of the Botanical Department in Trinidad bears testimony to the useful work which is carried on at the St. Clair experiment station. The Lagos "silk rubber" plant *Funtumia elastica* continues to be in demand, as the points in its favour are suitability to the climate, easy coagulation, and good rubber yield at an early age. The experiments with seedling sugar-canes are unfortunately limited by the small amount of space available for growing plots, but the demand for canes to the full extent of the available supply is a sufficient guarantee of the success of the undertaking. The cultivation of cotton in the West Indies would be the revival of an old industry. Through the cooperation of the Cotton Growers' Association, a quantity of seed has been provided for distribution, and prizes are offered for the best results.

THE botanical features of that district comprised in the Delta of the Ganges known as the Sundribuns are so unique that even after the surveys by Prof. Heinig and Mr. C. B. Clarke there still remains scope for the account which is presented by Dr. Prain in the *Records* of the Botanical Survey of India. This includes the first complete list of plants gathered in the district, with a guide to the genera and species, as well as a summary of the principal ecological associations, and observations on the manner in which they may have originated. First in point of interest comes the mangrove vegetation, which includes a heterogeneous collection of plants, many of which are characterised by the development of root suckers having a respiratory function; further, the collections of plants found at the sea face and in the clearings present problems in connection with the dispersal of species.

THE causes of acceleration and retardation in the metamorphosis of *Amblystoma tigrinum*, the adult form of the Mexican axolotl, form the subject of an article by Mr. J. H. Powers in the June number of the *American Naturalist*. According to the author, previous observers have been in error in attributing the retention of the larval form to inability to leave an aquatic life, and, conversely, the early acquisition of the adult condition to removal from water. The real factor in the case, he believes, is nutrition. A paper by Mr. J. H. Lovell, in the same journal, on the colours of northern gamopetalous flowers and their relations to bees and other insects, contains much matter of interest alike to the botanist and to the entomologist. The sequel will be published in a later number.

To vol. ii. No. 5 of *Marine Investigations in South Africa*, Dr. J. D. F. Gilchrist contributes some important notes on the development of South African fishes. The publication of these notes, which are confessedly crude and imperfect, would have been deferred until fuller investigations had been undertaken were it not for the circumstance that they have an important bearing on certain disputed points connected with the Cape fisheries. Many of the fishermen urge, for instance, that the spawn of several of the commoner food-fishes is developed on or near the sea-bottom, and is, in consequence, seriously damaged by trawling. To this the author replies that, since in northern waters it has been demonstrated that only one valuable food-fish, the herring, has deep-lying spawn, and since the Cape seas are the home of only a small species of herring of little or no commercial value, it is probable that the damage done by trawling in South African waters has been largely overestimated.

A PRELIMINARY report upon "Trypanosomiasis of Horses ('Surra') in the Philippine Islands," by Messrs. Musgrave and Williamson, has been issued by the Government Laboratory, Manila. The disease seems to have been recently introduced into the Philippines, for careful investigation has failed to show any evidence that it existed there before May or June, 1901. It is transmitted through the bites of insects, and until the exact species are discriminated, for preventive measures all insects should be considered as carriers of the infection. In Manila a certain number of the rats have been found to be infected with the horse trypanosoma. An account is given of the symptoms of the disease and of the preventive measures to be adopted, the most important of which is the prevention of the access of all flies and insects.

A SHORT time ago M. Blondlot announced the discovery of a new form of radiation found with Röntgen rays, and possessing the power of penetrating black paper and many metals. The rays could be reflected and refracted by quartz lenses, and were without photographic action; they could, however, be detected by their power of increasing the luminosity of small electric sparks or of a colourless "blue" flame. The rays were subsequently shown by M. Blondlot to be produced by an Auer burner. Following up his researches on these *n* rays, M. Blondlot has been led to discover some remarkable properties which they possess; these are communicated in a recent number of the *Comptes rendus*. It seems that the rays are capable of increasing the illumination given by an incandescent surface on which they fall, and this without any increase of temperature. An experiment which seems conclusive is quoted; a platinum wire which was heated to a dull red was subjected to the action of the rays, and whenever these were allowed to fall on it the incandescence was visibly increased. An auxiliary electrical circuit afforded a means of measuring the resistance, and hence the temperature of the wire, and this showed that the rays produced no increase in temperature; an increase of temperature too small to produce a visible effect in the incandescence of the wire was easily detected by the measuring circuit. This result is particularly interesting, not only in reference to the *n* rays of M. Blondlot, but in reference to theories of incandescence and light emission generally, as it seems possible that these rays may be able to throw some light on the many difficult problems that beset this subject. The remarkable properties that this radiation seems to possess promise to make it of unusual interest, and possibly also of great utility.

IN the *Gazette de Lausanne*, M. F. A. Forel directs attention to what appears to be a recurrence of the coloured circle round the sun (Bishop's Ring), similar to that which was observed after the Krakatoa explosion in 1883. The present phenomenon is paler than that first described by Mr. Bishop, and is supposed to be connected with the eruption of Mont Pelée in May, 1902. M. Forel states that it can only be seen at an altitude of not less than 2000 metres; it was first seen by him on August 1, and he points out that it would be very interesting if alpine climbers, or balloonists, would state when the ring was first observed by them, and whether its appearance is intermittent or continuous.

A CORRESPONDENT of the *Times* directs attention to a supposed cure for the mysterious malady known as mountain sickness. The discoverer of the specific is a Russian topographer named Passtoukhof, who, for some years past, has been making ascents in the Caucasus, where he has climbed the Grand Ararat, Mount Kasbek, and Mount Elbruz. At such high altitudes as these it is easy to understand that the question of mountain sickness becomes a serious one, and on more than one occasion M. Passtoukhof has found not only himself, but all the other members of his expedition, completely prostrated by it. On one of these occasions it occurred to him to try the experiment of lighting his spirit lamp and making some tea, which he administered to himself and his companions in an almost boiling condition, with a result that far exceeded his expectations. Almost immediately the more serious symptoms disappeared, and in a short time all the members of the expedition found themselves well enough to continue the ascent. Later on M. Passtoukhof repeated this experiment of using boiling tea as a remedy for mountain sickness, with results so invariably successful that he now feels justified in considering that it may really be regarded as a specific.

A CORRESPONDENT directs our attention to the fact that one feature of the programme at present in force at the Alhambra is an exhibition of the microbioscope. We are glad, like our correspondent, that science is being introduced—even in the form of amusement—to those who, in ordinary circumstances, take no interest in scientific matters, and think with him that more might be done even with existing resources to bring a knowledge of the advances of science under the notice of the people. "The music halls are," says our correspondent, "being increasingly used for good music; why not for good science? The managers will put money into it if the public respond, and no objection will be made to raising the tone of their programmes if the houses fill. Those interested in science need not spend the evening there; they could go to see just what concerned them."

THE Engineering Standards Committee has just issued "standard sections and specification" for tramway rails. If the series of rails be adopted, it should be easier for the British manufacturer to hold his own against foreign competition, which, in the case of tramway rails, is particularly severe.

WE have received the first parts of the monthly *Bulletin* of the Philippine Weather Bureau for 1903, prepared under the direction of the Rev. José Algué, S.J., director of the service. This bulletin, modelled on the plan of the United States meteorological publications, contains valuable climatological observations and general notes on the weather and crops. The report for 1902 contains an interesting account of the establishment and development of the service under the Spanish Government, and of its reorganisation and improvement under the United States. Meteorological observations were begun in Manila in 1865, and after many years of assiduous study of the behaviour of the typhoons of the eastern seas, Father Faura, the first director of the observatory, commenced his predictions of the approach of typhoons in July, 1879. These storm warnings have been the means of saving much life and property, not only in the Philippine Islands, but on the Chinese coasts. Their value is now fully recognised by the United States Government and by the Colonial Secretary and Chamber of Commerce of Hong Kong. On the recommendation of the chief of the U.S. Weather Bureau, a network of subsidiary stations has been established in the archipelago which will doubtless render invaluable service to our knowledge of the meteorology of the Far East.

A PAMPHLET of sixty-nine pages, extracted from the report of the expedition of the *Stella Polare* in 1899–1900, deals with the magnetic observations undertaken in the Bay of Teplitz by Captain Umberto Cagni. These observations were reduced by Prof. Luigi Palazzo, who gives the following results for July, 1899, and June, 1900:—Declination, 21° 10′ and 21° 18′ east; inclination, 83° 25′ and 83° 1.2′ north; horizontal intensity, 0.06846 and 0.06855; vertical intensity, 0.59319, 0.55990; total force, 0.59713, 0.56409. The principal instruments used were a unifilar Schneider magnetometer and a Kew inclinometer, but great difficulties were experienced in making the observations; among other inconveniences, snow was carried into the temporary observatory, and succeeded in penetrating through every crack or crevice.

SOME recent researches in the comparatively modern study of experimental phonetics are given by Prof. E. W. Scripture (Yale) in the *Medical Record* (February 28), and *Die neuern Sprachen* (January). In the former paper, Prof. Scripture describes the different methods that have been employed for registering the sound curves of the human voice. The method preferred by the author is to obtain a gramophone or phonograph record of the voice and to trace off an enlargement of the fluctuations either by mechanical or by photographic methods. In the second paper, Prof. Scripture describes a complete record of the melody of the Lord's Prayer as recited in the style characteristic of the eastern part of the United States. A diagram is given showing the main variations of pitch. An investigation in another branch of physiological acoustics, dealing with the audibility of vowel sounds under pathological conditions, is given by M. Marage in the *Comptes rendus* (February).

THE additions to the Zoological Society's Gardens during the past week include two White-crowned Mangabeys (*Cercocebus oethiops*) from West Africa, presented by Mr. C. R. Farquharson; an Ocelot (*Felis pardalis*) from Rio de Janeiro, presented by Mr. John Gordon; a Grand Eclectus (*Eclectus roratus*) from Moluccas, a Black-crested Cardinal (*Gubernatrix cristatella*) from Paraguay, a Red-headed Cardinal (*Paroaria larvata*), a White-throated Finch (*Spermophila lineola*) from Brazil, presented by the Right Hon. Earl of Crawford, K.T.; a Brown-throated Conure (*Conurus oeruginosus*) from South America, presented by Mrs. M. Moir-Byres; a Barred Dove (*Geopelia striata*) from India, a West African Love-bird (*Agapornis pullaria*) from West Africa, presented by Sir Arthur Bigge, K.C.B.; a Common Snake (*Tropidonotus natrix*), British, presented by Mr. Oliver Roberts; a Yellow Baboon (*Papio cynocephalus*) from Africa, a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, a Lion Marmoset (*Midas rosalia*) from South-east Brazil, an Echidna (*Echidna hystrix*) from New South Wales, two Stanley Parrakeets (*Platycercus icterotis*), two Tree Sparrows (*Passer montanus*), three Limbless Lizards (*Pygopus lepidopus*), a Muricated Lizard (*Amphibolurus muricatus*), a Cunningham's Skink (*Egernia cunninghami*) from Australia, a Lesser White-fronted Goose (*Anser erythropus*), two Jackdaws (*Corvus monedula*, var.), European; an American Glass Snake (*Ophiosaurus ventralis*), a Hog-nosed Snake (*Heterodon platyrhinos*), two Couch's Snakes (*Tropidonotus ordinatus couchi*) from North America, deposited; nine Summer Ducks (*Aex sponsa*) from North America, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER:—

Sept. 3. 8h. Saturn in conjunction with moon. Saturn 5° 26′ S.
5. 9h. 26m. Minimum of Algol (β Persei).
7. 5h. Mercury at greatest eastern elongation (27° 0′).
11. 18h. Jupiter in opposition to the sun.
12. Saturn. Polar diameter = 16″·3, outer minor axis of outer ring = 14″·39.
15. Venus. Illuminated portion of disc = 0·002; of Mars = 0·891.
17. 9h. Venus in inferior conjunction with the sun.
" 13h. 53m. to 14h. 36m. Moon occults α Cancri (mag. 4·3).
20. Sun totally eclipsed, invisible at Greenwich.
21. 7h. 13m. to 10h. 22m. Transit of Jupiter's Sat. III. (Ganymede).
23. 18h. Sun enters Libra. Autumn commences.
25. 11h. 9m. Minimum of Algol (β Persei).
27. 7h. 55m. to 11h. 2m. Transit of Jupiter's Sat. IV. (Callisto).
28. 7h. 58m. Minimum of Algol (β Persei).
" 10h. 30m. to 13h. 40m. Transit of Jupiter's Sat. III. (Ganymede).
30. 13h. Saturn in conjunction with moon. Saturn 5° 32′ S.

NEW TABLE FOR EX-MERIDIAN OBSERVATIONS OF ALTITUDE.—In existing tables for obtaining the difference between the observed and meridian altitudes, when determining latitude by ex-meridian observations, one has to refer to *two* separate tables, using as arguments declination, hour angle and approximate latitude. To remedy this Mr. H. B. Goodwin, R.N., has just published a pamphlet (Griffin and Co., Portsmouth) showing how the problem may be solved by the use of *one* table only, which is included in his pamphlet, using approximate latitude and azimuth.

The principle on which the method is based is that a body near the meridian may be regarded as changing its altitude with a uniform rate of change, and at any one interval we may take the *mean* rate of change as representative; and obtain the "reduction" to meridian altitude from the formula $dz = \sin A \cos l . dh$, where dz is the change of altitude and dh the contemporaneous change of hour

angle; dz for each half degree of latitude and azimuth is given in the table. All that one has to do to obtain the "reduction" is to take the approximate azimuth from any azimuth tables—and this has to be done for another part of the problem—then take out the rate of change, dz, from the Goodwin table and multiply this by the number of minutes in the hour angle.

RETURN OF BROOKS'S COMET.—A telegram from Kiel announces that Brooks's comet was observed by Prof. Aitken at the Lick Observatory on August 18, and that the position of the comet at 12h. 17·4m. (Lick M.T.) on that date was R.A. = 21h. 2m. 51·3s., Dec. = $-27° 4' 19''$. This position agrees closely with that given by an ephemeris computed by Herr P. Neugebauer, and published in No. 3868 of the *Astronomische Nachrichten*. The following is an extract from this ephemeris:—

Ephemeris 12*h.* (*M.T. Berlin.*)

1903	True α h. m. s.	True δ ° ′ ″	log r	log Δ
Aug. 27	20 56 24·95	−27 0 30·4	0·3284	0·07060
„ 29	20 55 12·95	−26 57 6·4		
„ 31	20 54 6·78	−26 52 54·0	0·3259	0·07321
Sept. 2	20 53 6·98	−26 47 53·8		
„ 4	20 52 13·90	−26 42 6·8	0·3234	0·07693
„ 6	20 51 27·98	−26 35 33·6		
„ 8	20 50 49·45	−26 28 15·2	0·3210	0·08165
„ 10	20 50 18·61	−26 20 12·8		
„ 12	20 49 55·67	−26 11 27·7	0·3187	0·08727
„ 14	20 49 40·87	−26 2 1·0		
„ 16	20 49 34·32	−25 51 53·8	0·3164	0·09369
„ 18	20 49 36·19	−25 41 7·0		
„ 20	20 49 46·55	−25 29 41·9	0·3142	0·10081

According to Aitken's determination of the comet's position, as given above, this ephemeris needs a correction of +22·58s. in R.A. and $+1' 41''·2$ in Dec.

Although not a bright object, this comet is of historical interest, because when it was first discovered by Brooks, in 1889, it was held to be a good illustration of the "capture theory" of comets, and was looked upon as identical with Lexell's lost comet of 1770, which had been "captured" by Jupiter. This belief was, however, discountenanced by the subsequent researches of Dr. Poor, of Baltimore. In 1889 Barnard observed the comet as double, and found that the two parts were slowly separating.

This comet has a period of 7·096 years, and was duly observed in 1896, when it performed its perihelion passage on November 4. For the present return the comet takes the designation 1903 *d*.

EPHEMERIS FOR COMET 1903 *c*.—An ephemeris for comet 1903 *c* is given in No. 3890 of the *Astronomische Nachrichten* by Herren M. Knapp and W. Dziewulski.

The comet is now too near the sun to be observed, but it will be observable by astronomers residing in the southern hemisphere after the middle of September.

α CORONÆ A SPECTROSCOPIC BINARY.—Using the 80cm. refractor and the No. 1 spectrograph of the Potsdam Observatory, Prof. Hartmann has determined that the radial velocity of α Coronæ Borealis varies from −20km. (May 28, 1902) to +38km. (June 3, 1902). The observations extended over the period May, 1902–July, 1903, and the respective velocities were determined from measurements of the lines Hβ, Hγ, Hδ, λ 4481 (Mg) and λ 3934 (Ca). The period of the binary is given as about 17 days (*Astronomische Nachrichten*, No. 3890).

THE ALLEGHENY OBSERVATORY.—In his report for 1902 the director, Prof. F. L. O. Wadsworth, laments the fact that the new observatory buildings and their equipments are not yet completed, and especially urges the necessity for mounting and housing the new 30-inch refractor, the discs for which have already been received from Mantois, of Paris; for this purpose a fund of sixty-five thousand dollars is required, none of which is yet subscribed or provided for.

An excellent electrical equipment for lighting and heating, and for all kinds of experimental work, has been donated by Mr. Westinghouse.

An efficient time service was maintained throughout the year 1902 in spite of instrumental difficulties. General observational work has had to be suspended pending the removal to the new observatory. A large number of mathematical researches have already been carried out, and others are suggested for future attention, by the director.

The latter part of the report is devoted to an outline of the work it is proposed to do when the new observatory is in full swing; this work includes exhaustive daily observations of all the solar phenomena and seismographic, gravitational, and magnetic observations.

THE RELATIONS BETWEEN SCIENTIFIC RESEARCH AND CHEMICAL INDUSTRY.[1]

THE particular branch of science with which I have been asked to deal at this meeting of university extension students—viz. chemistry—is perhaps better calculated to illustrate the intimate connection between scientific research and *productive* industry than any other subject. I emphasise the term *productive* industry because it is desirable to distinguish between productiveness and trade, *i.e.* buying and selling. With the latter I have nothing to do beyond pointing out the very obvious principle that, without something to buy or sell, there would be no commerce, and consequently productive industry must be put into the first rank. Now chemical products of various kinds are absolutely indispensable to all civilised nations. You may remember that many years ago Lord Beaconsfield said that the state of trade could be gauged by the price of chemicals. A writer in the *North American Review* in 1899 published an article in which he laid it down that the nation which possessed the best chemists was bound to come to the forefront in the struggle for industrial supremacy. Of course, "there is nothing like leather," and I am bound to agree with him. Had he been an engineer or an electrician he might perhaps have said the same for mechanical or electrical engineering. At any rate, it is perfectly safe to generalise his statement, and to declare that the nation which possesses the most highly trained technologists is bound to take the lead.

In so many ways does chemistry come into contact with nearly every branch of industry that it is difficult to know where to draw the line in giving actual illustrations of the industrial results achieved through chemical research. It is not possible logically, for example, to distinguish between the results obtained through research directed towards the solution of a particular industrial problem and the results obtained as by-products in the course of purely scientific investigation. Industry has been advanced, and always will be advanced, by both methods. Bearing in mind also that chemistry, in its widest sense, is essentially the science of matter—at any rate until the physicist has electrified matter into his own domain—it is evident that we are concerned not only with the production of useful materials for direct consumption, but also with the production of materials required in other industries. Thus chemistry affects engineers through the metals, cements, and other materials used for constructive purposes, and through the fuels used as sources of energy; it affects the agriculturist on account of the relationship between the growing plant and the composition of the soil, as well as through the relationship between the composition of crops and their value as food-stuffs; it supplies materials for the pharmacist, for the manufacture of pottery, glass and soap, for the paper maker, for the dyer and colour-printer, for the bleacher, tanner, brewer and spirit distiller; it furnishes the explosives used in modern warfare, and it supplies photography with all the materials necessary for the practise of that art. Among later developments it may be claimed that the modern science of bacteriology is the outcome of chemical research, and the manufacture of anti-toxins—the industrial result of this science—has until quite recently been in the hands of the chemical manufacturers. I may remind you also that many important products such as sodium, aluminium, phosphorus, calcium carbide, caustic soda, and chlorine are manufactured by electrical processes, so that the demand for these products has given an impetus to the development of applied electricity.

1 A Lecture delivered at the University Extension Meeting at Oxford on August 3, by Prof. Raphael Meldola F.R.S.

It is obviously impossible in view of the enormous range of industry in which chemistry is directly or indirectly concerned to do more on the present occasion than take a cursory glance at a few of the more striking cases illustrative of the connection between research and industry. As an example of the creation of an industry through research directed towards a special end, attention may be directed to the manufacture of optical and other glass at Jena. The history of this branch of manufacture, and the results achieved, have been fully described by Dr. Hovestadt in a work published three years ago, and of which a translation, by Prof. and Miss Everett, has been recently published in this country. I must refer you to this work for full particulars. The physical requirements to be complied with in order to produce the most perfect glass for the construction of lenses for optical instruments had long been known, and many attempts had been made to realise these conditions in practice. A visit to the international exhibition of scientific apparatus in London in 1876 led Prof. Abbe to direct attention once again to the fact that the future perfection of the microscope lay with the glass-maker, and in 1881 he, in conjunction with Schott, commenced a set of experiments having for their object the production of a series of glasses of known composition, the optical properties of which were concurrently determined by measurements made by Prof. Abbe. The experimental meltings were enlarged in scale the following year, and an experimental laboratory established for the continuation of the work at Jena. A chemist was added to the staff, and thus there were cooperating in this industrial research a glassmaker, a chemist, and a physicist. Before the end of 1883 the results had been so far successful that the Jena laboratory was in a position to make known to the world the processes for the "rational manufacture of optical glass." At this stage the experimenters were persuaded to put the results of their labour into practice, and the instrument makers, Messrs. Zeiss, having joined in, the Jena glass factory for producing optical glass on the commercial scale was established towards the end of 1884. In the first catalogue published by the Jena Works in 1886, we are told that forty-four optical glasses, nineteen being new in composition, were included. By 1888 the undertaking had been so successful that a supplementary catalogue was issued containing twenty-four additional glasses, of which thirteen were new, and in 1892 a second supplement announced the manufacture of eight more kinds of glass, of which six were new. Consider what this piece of work, prompted by science, fostered by the State, and carried out by a university professor in conjunction with a technologist has done for German industry. In the early stages of the experiments, before commercial results had been obtained, the experimenters were subsidised by the Prussian Education Department and by the Prussian Diet with a wise forethought which subsequent events have amply justified. Need I remind those who have come here to hear about bacteriology from Prof. Sims Woodhead how that science has advanced *pari passu* with the perfecting of the microscopic objective? The Zeiss instruments are now world-renowned, for it is obvious that a command over the processes for making glass with any particular optical properties that might be desired would enable the instrument maker to produce lenses suitable for other purposes, such as telescopes, field-glasses, photographic cameras, &c. I am afraid to dwell too much upon the perfection of the lenses of the Jena instruments because I lay myself open to the charge of holding a brief for a particular firm. If you want to know more fully what this optical glass industry has done for Germany, I refer you to the report on instruments of precision published in connection with the German exhibit at the Paris International Exhibition of 1900. As a further outcome the study of the properties of glasses of known composition in connection with their thermal and electrical behaviour has led to the manufacture of glass especially suitable for making thermometers, as also for electrical insulation, for the construction of the vacuum tubes used for producing Röntgen rays, and for the vessels employed in chemical laboratories. In brief, the manufacture of the finer kinds of glass has been placed upon a strictly scientific footing as the outcome of scientific research.

The next illustration which I propose to make use of refers to the applications of chemistry to agriculture. The growing plant, as you are aware, requires food for its growth just as much as the growing animal. Take an extreme case, and consider the size and weight of an oak tree as compared with the acorn from which it arose. This enormous accumulation of matter represents the assimilation of gaseous food in the form of carbon dioxide from the air through the leaves, and of water and nitrogenous and other mineral matter through the roots. It was the great German chemist Liebig who first established this broad principle of plant growth by systematic experiments upon various crops, and his results were given to the world in a work published in 1840, the English edition, edited by Lyon Playfair (afterwards Lord Playfair), bearing the title "Organic Chemistry in its Applications to Agriculture and Physiology." Perhaps few students consult this work now, but it was, strictly speaking, epoch-making on its appearance, because it brought the chemist into direct relationship with the farmer, and the consequence has been an enormous increase in the food-raising capacity of the soil. It is not necessary to inquire closely here into the motives that prompted Liebig's investigations—whether his work comes under the category of scientific researches directed towards a practical end, or whether he began with a desire of ascertaining abstract truth in the first place, and then found that his results were capable of practical application. It is quite immaterial from the present point of view how this work originated, because we are considering only the bearing of the results upon industry. It is evident that if a growing plant requires certain elements, such as potassium, sodium, phosphorus, nitrogen, calcium, magnesium, sulphur, chlorine, iron, &c., and if the soil by previous crops has been exhausted of some of these elements, it will not be possible to raise subsequent crops on this impoverished soil unless the necessary elements are supplied. In other words, the requisite elements must be added, and added in the form of compounds which the plant can make use of. Thus the great industry of crop-raising, and as connected therewith the feeding of farm stock, was shown to depend ultimately upon the chemical composition of the soil, and the manufacture of artificial manures or fertilisers has been the practical outcome of Liebig's researches.

Let us consider, further, the industrial results so far as these have influenced chemical manufactures. Prof. Warington can tell you all about the agricultural results. The elements which are most likely to fail, and which, in fact, have generally to be supplied, are potassium, phosphorus and nitrogen, excepting, of course, in the case of those particular leguminous plants which have developed a special means of fixing atmospheric nitrogen. Chemistry having thus been called upon to supply the agriculturist with compounds containing potassium, phosphorus and nitrogen, the first development which may be ascribed to Liebig's influence is the Stassfurt salt industry in Prussia, where immense deposits of salts containing potassium were known to exist. Similar deposits are found in Anhalt. The mining of these salts was commenced in 1860, and has proved an immense source of wealth to Germany, the total value of the Stassfurt and Anhalt salts produced down to 1890 being estimated at 11,500,000*l.*, and since that time the output has gone on increasing from year to year. It is not necessary to weary you with statistics, but it is important to note how the demand for potassium salts for agricultural purposes has given rise to a great industry, for the natural salts, consisting chiefly of carnallite, a double chloride of potassium and magnesium and kainite, a double sulphate of potassium and magnesium with magnesium chloride, have to be submitted to various processes in order to separate the constituents, and the Stassfurt salt factories are now supplying Germany, as well as exporting large quantities of potassium chloride and sulphate, magnesium chloride and sulphate, potassium carbonate, caustic potash, &c.

In a similar way the demand for phosphates has given rise to the utilisation of every available source of these compounds. Calcium phosphate is found as the mineral apatite, a double calcium phosphate and chloride or fluoride occurring in vast deposits in America, and also in a less definite form in Canada, the West Indies, France, Belgium,

and Germany. In this country calcium phosphate occurs in the form of coprolites, supposed to be the excreta of extinct saurians, in Cambridgeshire and elsewhere. All these natural phosphatic mineral deposits are mined, and have become valuable assets to the countries possessing them. The conversion of the minerals into a form suitable for the nutrition of crops is a branch of chemical industry involving the use of sulphuric acid for the conversion of the natural phosphate into the more easily assimilable form known as superphosphate. The greater part of the world's output of natural phosphates finds its way to Germany to undergo this treatment, the annual consumption of artificial manure in that country being estimated at something more than two million tons at a cost of about 5,000,000*l.* The mineral portion of the bones of animals, as you are no doubt aware, also consists largely of calcium phosphate, and before the mining of the mineral phosphates the conversion of bone ash into superphosphate was carried on on a very large scale. Bone ash is supplied now in large quantities from South America, but not much is converted into superphosphate, as the bones, after removal of the fat and the size (for glue), are capable of being finely ground, and are available for manure in this form.

Here is surely a romance of chemistry! The phosphates contained in the vegetation of the South American pampas go to build up the bony framework of the cattle which graze thereon. The skeletons of these beasts ultimately supply, let us say, the growing crop of a beet sugar manufacturer in Germany with phosphates. The phosphates picked out of the soil by South American vegetation concentrate in the bones of cattle, and are then sent into circulation in German beet. Or, even more striking, the phosphates accumulated by the great lizards of a remote geological age are now circulating through growing crops. This circulation of matter through the intervention of the living organism is an every-day story to the chemist. To our greatest poet apparently it was also known:—

"Imperious Cæsar, dead and turn'd to clay,
Might stop a hole to keep the wind away:
O, that that earth which kept the world in awe,
Should patch a wall to expel the winter's flaw!"

But we must descend from romance to reality. The deposits of sea birds also contain phosphates derived from the fish upon which they feed, and these deposits often accumulate in such large quantities as to make them available for agricultural purposes. Under the name of guano, immense quantities of this material, which contains both phosphates and nitrogenous matter, are exported from Peru. There is subject-matter for philosophising here, also, about the circulation of phosphates from marine organisms through birds into growing crops, and so forth, but time will not admit of many side disquisitions if I am to keep to my text. As another source of phosphate, it is of interest to know that the basic slag obtained in the Thomas-Gilchrist process of making steel is now largely used, so that the work set going by Liebig has, among its latest developments, led to the utilisation of a waste product of the steel industry.

Excepting in the case of leguminous plants, which are capable of utilising atmospheric nitrogen by a process which it does not come within my province to explain, the ordinary source of nitrogen for growing plants is a soluble nitrate, and if the soil is poor in such salts, they must be supplied either directly or indirectly through salts of ammonia, which are converted into nitrates in the soil by bacterial action in a way that nobody is better able to explain to you than Prof. Warington. The great natural deposits of sodium nitrate which occur in Chile and Peru supply practically all the nitrogen applied to the soil in this form for fertilising purposes. With respect to ammonia, the destructive distillation of coal for the manufacture of gas and tar products, or for the production of coke, furnishes practically all the salts of this base required for agricultural and other purposes. The vital importance of assimilable nitrogen to growing crops has led the chemist also to study methods for the fixation of atmospheric nitrogen so as to render this element available for such purposes. It has long been known that nitrogen and oxygen can be made to combine under the influence of the electric spark. This, as you may remember, is one of the methods used by Cavendish in his classical researches on the composition of the air, and it was used also by Lord Rayleigh to separate atmospheric nitrogen from argon. Sir William Crookes has shown that the combustion can be brought about by the electric flame with such facility as to render the production of nitrite and nitrate by this process an industrial possibility, and the manufacture has actually been started in America by utilising the Falls of Niagara for the generation of the necessary electric power. Still more recently it has been found by Caro and Frank that when lime and coal are heated in the electric furnace, the calcium carbide fixes atmospheric nitrogen to form a compound known as calcium cyanamide, and this decomposes in the soil with the liberation of ammonia, so that the nitrogen of the air is thus rendered available for plant nutrition by an electro-chemical process. The manufacture of this "Kalkstickstoff" is in the hands of the electrical engineering firm of Siemens and Halske, in Berlin.

There has been no straining of facts on my part in this sketch—necessarily brief—of the industrial results of Liebig's work. The establishment of the fundamental truths was a piece of pure scientific research. Had it not been made known by the irrefragable proofs furnished by scientific method that such and such elements were essential for plant growth, the mineral resources of the earth would have remained unused for this purpose. The minute percentage of nitrogen locked up in the fossilised vegetation of the Carboniferous period would never have been isolated in the form of ammonia and applied to the soil for the nourishment of the crops raised by the present day agriculturist. The successful cultivation of the beet as a source of sugar has been made possible by this knowledge, and it may be of interest to add that the further scientific study of the cultivation of that root in Germany has led to the yield of sugar being increased from 5¾ to 13 per cent. during the period commencing about the year 1840 and ending at the present time. The economic result of this industry upon our own sugar-growing colonies is a fiscal question which does not come within the province of this address.

Equally instructive as illustrating the connection between scientific research and industry is the production of alcohol and other valuable products through the agency of living organisms. The spontaneous conversion of saccharine solutions, such as the juice of the grape, into solutions containing alcohol, with the concurrent development of gaseous carbon dioxide, is among the earliest recorded observations in applied organic chemistry. The various theories which were from time to time advanced to explain what is called "fermentation" are now of historical interest only. It is to the researches of Pasteur that we are indebted for the placing of the fermentation industries on a scientific foundation. This illustrious chemist, who as far back as 1860–62 had successfully disproved the so-called "spontaneous generation" by showing that the ordinary air was always charged with living germs, turned his attention to the diseases of wine, with the object of assisting an industry of great national importance in France. His "Études sur le Vin" was published in 1872. A greater work—the great classic of the science of fermentation—appeared in 1876 under the title "Études sur la Bière." In this work it was definitely proved that the transformation of sugar into alcohol is a biochemical change; that the yeast which produces this change, and of which the organised nature had long previously been suspected, is, in fact, a low form of vegetable life allied to the fungi, and that it multiplies and grows at the expense of the sugar and other materials contained in the fermenting liquid, the alcohol and carbon dioxide being the products of its activity. It is now known, through the work of Buchner, that this chemical transformation of sugar into carbon dioxide and alcohol is the result of interaction between the sugar and a certain definite substance—an unorganised ferment—which is formed by the living yeast cell, and which can do its work independently of the cell in which it originated.

The scientific development of the fermentation industries followed from this and other work of Pasteur's. The names of those who have taken part in these later developments are numerous and illustrious, but want of time prohibits a detailed survey of this most fascinating chapter

of biochemistry. The leading idea that the formation of alcohol is a biochemical process depending upon certain organisms, or, as we may now say, upon the products of certain organisms, carries with it, as a necessary consequence, the conclusion that the industrial production of alcohol—whether for brewing or spirit distilling, or for the chemical manufacturer—is not an empirical or rule-of-thumb operation depending upon unknown conditions, but a definite chemical change produced in a definite way by a definite organism (yeast), and just as much under control as any other chemical operation. The chemist and the brewer have thus also been brought into association. The recognition that definite chemical transformations can be effected by microscopic forms of life which resulted from Pasteur's studies in wine and beer has had such far-reaching consequences that it is impossible to overestimate the importance of this work for the well-being of humanity. I should be encroaching upon the domain of Prof. Sims Woodhead were I to do more than remind you of the growth of that modern science—the most humanitarian of all the sciences—bacteriology, out of this fundamental conception. Keeping to the main topic of industrial results, one outcome has been, as I have said, to bring the operations of the brewer under scientific control. The organism, the yeast introduced into the vat to induce fermentation, must undergo careful microscopic examination to see that it contains no deleterious organisms, *i.e.* no organisms which would give rise to products other than alcohol. The water used by the brewer must be analysed to ascertain whether it contains the necessary mineral constituents for the nourishment of the yeast, because this plant is subject to the same conditions of growth as any other plant. Instead of obtaining its carbon from carbon dioxide, however, it can utilise sugar for this purpose, and it decomposes the sugar into carbon dioxide and alcohol in the way indicated.

The recognition of yeast as a vital chemical reagent which is apt to contain impurities in the form of wild or stray organisms which may damage the contents of the brewing vat, has led further to the introduction of the process of brewing by what is known as "pure culture yeast." This industry, of which the home is chiefly on the Continent, depends on the use of a yeast cultivated in the first place from a single cell of some particular species or variety or race by methods similar in principle to those adopted by the bacteriologist, the cultivation being carried on from generation to generation in carefully prepared solutions containing the necessary nutrient materials, sugar, nitrogenous matter, mineral salts, &c., and previously sterilised by heat so as to destroy every other form of life. The brewer can now be supplied, as the outcome of a series of brilliant investigations by Hansen, of Copenhagen, to whom he is indebted for this purification of the biological foundation of his industry, with a cultivated yeast as pure in strain as a pedigree horse or a particular breed of dog —a yeast which, by virtue of its purity, can be depended on for giving constant results in the brewing vat. This is another illustration of the relationship between research and industry.

Consider, in the next place, the sugar which the yeast decomposes by virtue of its zymase. In an ordinary brewing operation the liquor which is fermented is not supplied in the first place with sugar as such, but the starch contained in the barley grain is ultimately broken down, as chemists say, into sugar by virtue of certain processes which I cannot stop to explain. But the broad fact is that yeast cannot feed upon starch, but only upon sugar, and, in fact, only upon certain kinds of sugars, and the starch which is stored up in the barley is the raw material which ultimately supplies the necessary kind of sugar. So that starch, which, as you know, is a substance very widely distributed in the vegetable kingdom, can be extracted if necessary from the seeds or tubers which contain it, and converted into sugar by chemical processes, and then used for the production of alcohol. An important industry is flourishing in Germany at the present time for the production of alcohol from potato-starch. In Berlin a few weeks ago we were shown over a large establishment entirely devoted to the fermentation industries, and potato spirit and other products from the potato were the most conspicuous features of the exhibition. Now alcohol is a substance of great importance for chemical industry in many directions, and its inflammability makes it valuable as a fuel, so that the problem of the cheap production of alcohol is worthy of the serious attention of investigators. It is interesting to contemplate the period when our natural sources of fuel, coal and petroleum, are all exhausted, and when we may have to fall back upon the vital activity of a lowly form of vegetable life to supply us with liquid fuel. Scientific research has helped here, also, to call a new industry into existence, because the cost of alcohol, like that of any other chemical product, is obviously dependent upon the yield, *i.e.* upon the quantity obtainable from a given weight of raw material. I must claim your indulgence while I trace in brief outline one of the most beautiful of the modern industrial developments of the principles of fermentation.

It had long been known that in Java an alcoholic beverage, known as arrack, was prepared by fermenting molasses with a peculiar ferment prepared by a special process from rice. From what has been previously said, you will understand that the starch contained in rice is not, as such, available for direct alcoholic fermentation. A detailed scientific investigation of the starch-fermenting materials used in Java and elsewhere in the Far East has revealed the fact that these ferments owe their activity to the joint action of two out of several different organisms which are contained in them. One of these is a mould fungus which has the property of saccharifying starch, *i.e.* breaking it down into sugar, and thus rendering it available for the growth of the other organism, which is a yeast capable of exciting alcoholic fermentation in the usual way. Now the principle revealed by the scientific study of these eastern ferments has been developed into an industrial process for producing alcohol from starch of any origin, such as from maize, rice, potato, &c. The operations, in the briefest possible terms, consist in saccharifying the prepared starch by a pure culture of mould fungus, and then fermenting by means of yeast. The problem of increasing the yield of alcohol has thus been solved; not only is the spirit obtained in more concentrated form, but the actual percentage of alcohol furnished by a given weight of starch is much greater than has ever been obtained by any of the older processes of fermentation.

I have left but little time for dealing with an industry with which I have had long personal connection—the manufacture of colouring matters and other products from coal tar. The relations between scientific research and this industry are so intimate, and are so frequently referred to in public, that it has become a kind of stock example for the use of those who wish to emphasise the interdependence of science and industry. The history of this industry, moreover, is particularly instructive from our present point of view, because it originated in this country in 1858 and flourished here for a period of about twenty years, and then began to decline. The chief centre of activity for the production of coal tar products at the present time is Germany, where there are six large factories and a number of smaller ones. The aggregate capital of the six large factories amounts to some 3,000,000*l.*, and they give employment to about 20,000 people, including chemists, engineers, clerks and travellers, dyers and draughtsmen, workmen, &c. These large firms pay dividends varying between 5 and 25 per cent. upon their capital. The total value of the tar products manufactured in Germany exceeds 10,000,000*l.* annually, and she supplies by far the largest proportion of the dye-stuffs used throughout the world. When, in 1886, I proclaimed our approaching fate with respect to this industry, I found that we were then using about 90 per cent. of German and other foreign colouring matters in this country, and my friend, Prof. Arthur Green, of the Yorkshire College, finds that things are in about the same state at the present time.

The coal tar colour industry arose, in the first place, from an observation made by Dr. W. H. Perkin in 1856 in the course of a research having for its object the synthesis of quinine. He did not succeed in producing the alkaloid, but he noticed that aniline, when oxidised, gave a colouring matter, which he manufactured and introduced under the name of "mauve," and so laid the foundations of an industry which has developed to its present colossal dimensions. The art of the dyer and calico-printer has been

absolutely revolutionised by the introduction of the synthetical colouring matters prepared from coal tar. Of these more than 500 are now available—each one a distinct and definite chemical compound with characteristic colour; each one with properties rendering it suitable for application to particular classes of fabrics. Every range of colour, including the deepest black, can be imparted, and every degree of brilliancy or dullness, of fastness to light, to washing and bleaching agents, &c., can be realised as required. The natural dye-stuffs, such as madder, which supplied alizarin for Turkey red; the cochineal insect, which furnished a red dye; the lichens and dyewoods, which were used by the old-time dyers, have been displaced, or are on the way to displacement, by the tar products. The most important of all the natural colouring matters, indigo, is, as you know, among the latest of the achievements of industrial synthetical chemistry, and a great industry worth some 3,000,000*l.* annually to our Indian Empire is threatened with extermination by the German manufacturers. Not a month passes without the introduction of new colouring matters, and so enterprising are the German colour makers that their pattern-books are issued with full directions in various languages, and trained chemists in their service will give personal instructions to our dyers in the application of new and unfamiliar colouring matters.

It is impossible to do more than allude in passing to the enormous influence of this greatest and most refined of all the chemical industries upon every other department of chemical manufacture. It has reacted, and is reacting, with ever multiplying ramifications upon the manufacture of the raw materials such as acids and alkalis, it is revolutionising the methods for producing sulphuric acid, it is pressing into its service electrolytic processes, and it has created new branches of engineering for the construction of special plant and machinery. The utilisation of the infinity of compounds present in the tar is no longer restricted to the production of colouring matters. Valuable medicinal preparations, photographic materials, perfumes, antiseptics, the sweet-tasting saccharin, which is 300 times sweeter than sugar, an artificial musk which exceeds in intensity of odour any natural musk, are among the manufactured products from coal tar. The industry is the direct outcome of scientific research; it has been developed by research, and is being still developed by research. Both methods referred to in this address have been, and are, at work. The by-results of pure scientific investigation are seized upon whenever they show the slightest chance of being industrially useful. Saccharin is such a by-result. The chemical reactions which culminated in the industrial production of indigo were published by their discoverer, the late Dr. Heumann, as an academic discovery in the first place, and were developed industrially by the "Badische Anilin und Soda Fabrik" of Ludwigshafen. By the other method whole armies of highly trained scientific chemists are constantly at work in the splendidly equipped research laboratories of the German factories investigating new products and processes with the direct object of their ultimate industrial application. Nor must it be forgotten that under the term "research" used in this connection is comprised also theoretical research. A close study of the history of this industry will show how throughout it has been vitalised by theoretical conceptions concerning the chemical structure of the molecules of organic compounds, and especially by the so-called benzene ring theory of Kekulé, now so familiar to chemical students. The force of illustration of the connection between science and industry can, perhaps, go no further than in this case, where a purely abstract conception based on a knowledge of the properties of the atom of carbon has reacted upon a branch of manufacture to its lasting benefit.

I have thought it best to limit my treatment to the record of bare facts in order to bring home to you in a concrete way how chemical industry and chemical research are interdependent. Four groups of industries have been dealt with; it would have been easy to subdivide the subject and to deal with four dozen. I must confess that I am getting rather tired of what may be called the platform treatment of education in applied science, which consists in general of the purely clerical or office-boy work of compiling information—doubtless very valuable in its way—concerning the number of schools in foreign countries, the acreage of land which they cover, their cubic contents, cost of erection and maintenance, the number of professors and staff, and the number of students which they turn out annually. The reason why this kind of information is getting stale and wearisome is because it produced at first no effect at all in this country, and then it led to a reckless expenditure in bricks and mortar, and the starting of institutions which are inadequately endowed, insufficiently maintained, and altogether lower in their working capabilities than the continental institutions which prompted their foundation. I thought, therefore, that it might be more acceptable if, instead of dealing with the usual generalities of the statistical order, I sketched the history of a few specific industries. If it appears that Germany has played a very prominent part in these histories, all I can say is that there has been no intentional selection on my part, but it is entirely due to the circumstance that it is to that country more than to any other that industry owes its advancement by scientific method. The preeminence of Germany in chemical industry is sufficiently notorious, as our own manufacturers know to their cost. The most striking feature of the exhibition at Paris in 1900, when, as a member of the International Jury for Chemical Products, I had occasion to examine the exhibits of all countries, was the collective exhibit of chemical products displayed by some ninety German firms. This splendid collection, which revealed more than anything the enormous advances made in chemical industry by Germany, is now deposited in a special building in the grounds of the Technical High School at Charlottenburg.

So much has been said and written about the causes of this wonderful development of German chemical manufactures that I hesitate to add anything more to the discussion. Certainly it is not possible to add anything new. Those who, like Prof. Michael Sadler and Dr. Rose, have made a special study of German educational systems have placed before the public valuable reports in which these causes are fully discussed from the educational point of view.[1] In the official report to the French Government on the products of Class 87, Prof. Haller, the secretary to our jury and author of the report, has devoted a whole section to the "Causes de la Prospérité de l'Industrie chimique Allemande." The general conclusion to which we have all come concerning this remarkable industrial development is that it is mainly due to the higher educational level in Germany with respect more especially to the highest scientific instruction in the universities and technical high schools. It is perhaps permissible to go one stage further back, and to say that this advanced scientific education is in itself the expression of the public faith in such education, and the recognition by the State of the industrial value of such training. It has been well pointed out that the money invested by the German nation in founding and maintaining the chemical chairs at the universities and technical high schools is now worth some 50,000,000*l.* annually to the country in this branch of industry alone. More especially, also, it may be claimed that the recognition of the value—the indispensable value—of scientific research to industry by the manufacturers themselves has been one of the most potent factors in developing German chemical industry, and the lack of such appreciation on the part of our own manufacturers has been one of the chief causes of their decadence.

In so far as the subject under consideration is an educational one, it comes within the province of a gathering of students held under the auspices of the most ancient seats of learning in this country. At any rate, the topic is one of such supreme importance to the welfare of this nation that I could not resist the invitation to take part in your proceedings, because the question is one which has been for years undergoing the most serious consideration by those who have, like myself, been connected on the one

[1] See especially vol. ix. of the special reports issued by the Board of Education, entitled "Education in Germany," by Prof. Sadler. Also Dr. Rose's diplomatic and Consular reports, issued by the Foreign Office, No. 561, "Chemical Instruction and Chemical Industries in Germany"; No. 591, "German Technical High Schools"; No. 594, "Agricultural Instruction in Germany and the Development of German Agriculture and Agricultural Industries."

hand with manufacturing industry and on the other hand with the teaching of science. Whether the old universities are desirous of making a new departure and of enlarging their spheres of activity so as to bring them more into harmony with the practical requirements of the age I have no authority to discuss. Certainly Cambridge, by the establishment of departments of engineering and agriculture, has made a distinct advance in this direction. At any rate, it may be taken as a sign of the times that the relationship between science and industry has been made a special feature of this year's university extension meeting, and the outer world will no doubt take due cognisance of the circumstance that a subject has been chosen for consideration which, in this country, is generally considered quite remote from the higher ideals of university education.

It is evident from what has long been going on in Germany and America, and from what is now taking place with regard to education by our newer universities here, that applied science is, or can be, brought within the province of university education. Of course, if the view be held that science is degraded by being turned to practical account, then we must not look to the universities for the training of our industrial leaders. It is impossible, however, to note the progress of events since the coalescence of science and industry abroad without coming to the conclusion that the position of a nation in the scale of civilisation will be measured in the future by its productive energy—by the capacity of its workers to evolve new ideas and to carry them out practically; by the number, zeal and originality of its scientific workers, and by their mastery over the resources of nature. I do not mean to imply that the old universities have done nothing towards the education of scientific thinkers and workers. What strikes outsiders like myself is the very small part that these universities are taking in the modern equipment of the great industrial army of Britain as compared with the work being done by foreign universities for their respective countries. In view of the industrial struggle between nations which has arisen through the discoveries of modern science—a struggle which is bound to become keener with the progress of science—it cannot be seriously maintained that the material welfare of our country is beneath the dignity of even the most profound academic scholar. The old definition of a university as an educational centre for the cultivation of useless knowledge no longer holds good. If there are universities which still cling to this tradition concerning their functions, it may safely be predicted that their influence in moulding the future life of the nation is destined to shrink to smaller and smaller dimensions.

The part played by the German universities and technical high schools in the training of technologists is now so well known in this country that a detailed restatement of the facts is hardly necessary. I may remind you that their twenty universities, with foundations dating from the fourteenth to the beginning of the nineteenth century, for many years supplied the factories with men thoroughly trained in science, and capable of applying their knowledge to industrial processes. With the development of manufacturing industry along scientific lines it was found necessary to provide more specialised education, and during the first half of the nineteenth century trade schools or polytechnics were called into existence in nine different centres. Of course, you know that our polytechnics here have very little analogy with the German institutions of that name. The polytechnics were in time found inadequate to meet the growing requirements of German industrial training, and their functions were accordingly enlarged and their educational status raised. Out of these nine polytechnics or trade schools have arisen nine technical high schools, and two more such schools are now in course of erection. Thus in Germany both universities and technical high schools are catering for the scientific needs of the national industries. I may add that a few years ago there was a serious discussion in Germany among certain educational bodies and industrial organisations as to whether the State should not be asked further to strengthen the scientific faculties of the universities by creating chairs of technical or applied chemistry, and although there has been no practical outcome of this movement as yet, it is an instructive illustration of the spirit which is abroad in that country.

There is very much misapprehension here concerning the nature and functions of the German technical high schools. They are not glorified polytechnics of our own type for teaching handicrafts to artisans or smatterings of science to ill-prepared students. They are institutions of university rank—their education is of university standard, and their professors stand on a level with the professors of the universities. Their students are not admitted until they have reached a high standard of general secondary education. Their courses of instruction are as purely scientific as the university courses, and the only difference between the two kinds of education is that the technical high school is all scientific, and the various sciences are taught both theoretically and practically with a view to their ultimate industrial applications. It is a "technical education" in the highest and best sense, and not in the narrow—I may even say degraded—sense in which the term is so frequently used in this country.

The question of the hour which the old universities have now to face is whether they are willing to take part in the newer education required by our industrial leaders, whether they are prepared to strengthen and develop the teaching of those physical sciences which underlie productive industry, and to recognise the claims of the applied sciences as subjects worthy of inclusion in their curricula. There will, of course, be a divergence of opinion with regard to this question. There will be the old, old conflict between the advocates of the "humanising" influence of the ancient classical studies and the supporters of modern scientific education. So far as my opinions are worth anything, I cannot see, and I never could see, why a study of nature at first hand should be less "humanising" than the study of those classical subjects which have so long held the field. I admit that the teaching of the physical sciences as they should be taught at the present time in any institution of university rank is more costly—that the equipment consists of something more than a library, and that their teachers, to be effective, should be themselves active investigators, inspiring originality and a desire for creating new knowledge in their students. I can understand that a subject which to the classical don wears the aspect of a financial ogre should be kept down as long as he has a preponderating influence in regulating the affairs of his university. But this is a matter of expediency, and not a real conflict between fundamental principles. I cannot find that the classical teaching of the American or German universities has been impaired by the splendid development of their scientific faculties; neither does it appear that the human products of their scientific activities are in the least degree inferior as men to their classical scholars. Of course, I am a special pleader, and I am making the best use of my opportunities, and I repeat that I never could see where any antagonism existed between the older and the newer studies excepting in the struggle for financial means. There are many educational authorities here and abroad who will tell you that the scientific development of the German universities has reacted upon and improved the classical teaching by an infusion of scientific method into the latter. Moreover, it must be remembered that we who are advocates for the new education are not clamouring, as many people think, for the abolition of the old studies. I for one should deplore any falling off in the prestige of the old universities as seats of classical learning. Neither is it suggested that our future leaders of industry would never at any period of their studies derive benefit from that particular kind of culture which the ancient literature is capable of imparting. I firmly believe they would; but the question as to when and how would open up the whole field of education, elementary, secondary, and university, both pre- and post-graduate, and I should find myself floundering among shoals and quicksands in no time. The ideal university is one that offers facilities for both the older and the newer education; they are not mutually exclusive—they can, and do, thrive side by side elsewhere, and there is no reason, at any rate no theoretical reason, why they should not do so here.

The form in which the question may be put is therefore whether, given the means, the older universities should

develop their work in the direction of applied science. A large body—I cannot say how many—of outsiders who are well-wishers of these universities is of opinion that they should, and there is an idea abroad that they are suffering financially now from having neglected this side of education in the past. There was, for example, a leading article in the *Times* of May 25 in the course of which the writer suggests that they may have suffered through having a false reputation for being very wealthy bodies, and he adds:—"Or is it perchance, because the modern millionaire, being a man of his age and an Englishman to boot, has no great belief in the economic value of knowledge as such, and no great confidence in the capacity of our ancient universities to adapt themselves to the needs of the coming time?" Now, so far as the chemical manufacturers of this country are concerned, I can say with some personal experiences of my own that they certainly have shown no great belief hitherto in the economic value of scientific knowledge, as they now know to their own cost. But if, to make a purely hypothetical conjecture, some beneficent millionaire were to test the capacity of our old universities for undertaking this kind of work, and were to offer adequate means for the purpose, I feel pretty confident, from what I know of the spirit which dominates their governing bodies, that such an offer would be accepted both at Cambridge and here at Oxford with few dissentients. If such a departure were placed within their power, I think that that great public which glories in the past achievements of these universities would rejoice in their new development. And I will further add that the creation of chairs of applied science would react upon and strengthen the teaching of all those sciences which are in any way connected with industrial productiveness.

Of course, this is all hypothesis—the most nebulous of hypotheses. We all know, unfortunately, that the financial resources of the universities have been, and are, inadequate for the purpose of enabling them to meet the requirements of modern scientific education, either in the way of staff, accommodation, or equipment. It can be said, and justly said, that so long as these universities are without the means of developing their schools of pure physical science to an extent worthy of their reputation, it is useless to talk about developing the teaching of applied science. So it may be. But I remind you that we are still in the region of hypothesis, and the captious critic might retort by saying that they have not done even as much as they might, and could, have done for the proper development of scientific teaching with the means already at their disposal—that they are still overweighted by ancient tradition, and that their internal scientific forces are still feeble as compared with the preponderating forces of the advocates of the older culture. There is no time, even if I knew enough about the inner mechanism of university administration, to discuss this aspect of the question, but if you want to know an American view of the case—a strong view!—I would invite attention to an address by Prof. Victor Alderson, Dean of the Armour Institute of Technology, delivered before the Chicago Literary Club in October last year, an abstract of which was published in NATURE of February 12.

The question of the recognition of applied science by our old universities must, as I said, be faced—the time is at hand for them to consider seriously whether it is desirable that they should cater for the training of those who are destined to be the founders and upholders of our national prosperity. The longer this question is shelved the smaller will grow the chances of their being able to participate in the work. At present we in this country are not up to the German level so far as concerns the higher technical training of industrial leaders. Our universities, in other words, have not yet had to encounter the full force of competition with newer institutions of the rank of the technical high schools. We have but very few, if any, schools of this status here now, but if I read the signs of the times correctly, the differentiation between the old and the new education—which has already become well marked—is bound with the progress of science to become more and more strongly pronounced. Our newer universities—especially those in large manufacturing centres—will be driven more and more into the teaching of applied science, and our polytechnics and technical colleges will perforce have to raise their educational standard. The effect cannot but be to cause the older universities to become of smaller importance in the general scheme of national education as time goes on. That is why I have taken advantage of the opportunity which has been placed in my hands for raising this note of alarm, because even if nothing practical results from this meeting, it may at any rate be useful to let it be known that many of us desire to see the most ancient and the most renowned of our educational foundations doing more for the education of a nation the prosperity of which is so largely dependent on productive industry.

Whether as the outcome of the lectures delivered and the conferences held during this meeting the attitude of the universities towards applied science undergoes modification or not, the ventilation of opinions cannot but be of advantage in many ways. If, for example, it is made manifest that the current of national thought is moving slowly—alas! very slowly—towards the recognition of science as the main factor of industrial progress, it may help to emphasise the necessity for strengthening and developing the teaching of pure science. If the beneficent millionaires are not forthcoming for the purpose of endowing applied science, there is, at any rate, ample scope for their beneficence in the endowment of pure science in our old universities. A school of active science workers would—to use a quasi-scientific expression found in the pages of many writers of fiction—"galvanise into life" the science teaching of the schools. If you can only help to mould the public mind into the belief that science is a living reality veiling truths of inestimable value to humanity from every point of view, moral, social and material—truths that are to be wrested only by conscientious, laborious and persistent *research*—you will be assisting a great cause. If you will proclaim this doctrine from the house-tops and assist in sweeping away that dust heap of formal text-book knowledge which passes for science in our examination rooms you will be doing something towards raising the general level of opinion in this country. We need it badly! Think of all the creative intellectual power running to waste—the unrealised assets in the way of originality of thought which Great Britain might have at her disposal if the brain power of her teachers and students were only diverted into the right channels. The old universities, by virtue of their prestige, their traditions, and their past achievements, have still a powerful hold upon the public mind. They must open their doors still more widely to science if they wish to retain their hold. If their means are at present insufficient to enable them to meet the requirements of the age, they can still forward the national cause by upholding the dignity of science, by insisting upon originality of thought as an essential qualification for its successful teaching, and by helping to dispel the notion that it undergoes degradation by being applied to human welfare. It must be realised, and it cannot be realised too soon, that the peaceful campaign of industrial competition requires leaders well trained in scientific method, and not crammed with mere formal book learning—men as alert in mind and resourceful in meeting difficulties, as upright in principle, as keen in enthusiasm, as far-seeing in imagination, and with as intimate a knowledge of human nature as the statesmen, warriors, divines, lawyers, and schoolmasters which these old universities have given to their country. The victory of the future is with that nation which enables her children to approximate more closely towards Tennyson's ideal:—

> ". . . the crowning race
> Of those that eye to eye shall look
> On knowledge; under whose command
> Is Earth and Earth's; and in their hand
> Is Nature like an open book."

IRRIGATION WORKS.

INDIA.

IN a recent number of the *Revue générale des Sciences* is an article on irrigation in India which is interesting as showing the impression made on the mind of a foreigner after an inspection of the great works that have been carried out under the British administration for mitigating the

effects of famines and improving the condition of agriculture. In a report published a few years ago by Mr. Deakin, the Minister of Water Supply in Victoria, under the title of "Irrigated India," Mr. Deakin stated that, in his opinion, after an inspection of the irrigation works in Italy, Egypt and America, he was satisfied that there was no canal system in the world that could hold comparison with that of India, and expressed his surprise that so little was known of it. The area of land irrigated in India by canals amounts to about 30 millions of acres, six times that of Egypt, and nearly double that of the whole of the rest of the world. M. Chailley Bert, the writer of the article under notice, after spending considerable time in inspecting the various irrigation works, seems to have come to very much the same conclusion. He expresses his opinion that, after the principles of the general administration of the country, and the conduct of the English in India, there is nothing of more interest and more worthy of observation than the system of irrigation, the methods pursued in carrying out the works, and the results that are obtained.

From all time there has existed a close relation in India between famine and irrigation. The ancient rulers of India have left everywhere traces of the great works which they had carried out for overcoming the want of rain and providing against the constant recurrence of famines; and since the English administration irrigation has been forced to the front by the terrible famines which periodically visit a portion of this vast territory, in every instance caused by deficient rainfall, which sometimes lasts for two or three consecutive years. The great famine of 1837 in Bengal led to the project of the Ganges Canal, which has now 5500 miles of main canals and branches; that of 1853 to the works at Madras; that of 1859 to the works in the north-west. The famine which desolated Orissa and the north of India in 1864, when a million of the inhabitants lost their lives by starvation notwithstanding the expenditure of 1½ millions of pounds in combating the famine, and also more than 3 millions in works of irrigation, resulted in the policy of systematically carrying out extraordinary public works by which it was contemplated to spend half a million a year in developing irrigation for the purpose of preventing the recurrence of these terrible disasters. During the terrible famine of 1876, for which a large relief fund was raised, 5¼ millions of lives were lost, although the Indian Government expended 11 millions in relief.

The rainfall of India is very various, amounting to 200 inches in a year in some districts, while in others the fall does not amount to more than from 2 to 10 inches; and over a vast area the land is dry and sterile, except where the rivers have been canalised, or the rain coming from the mountains has been caught and stored in reservoirs.

The peasants inhabiting these districts are described as being utterly improvident, and population goes on increasing at an enormous rate. The dry and unfertile years find them without any resources, and when famine comes untold misery ensues, and the population is decimated by starvation and death.

A vivid description is given by M. Chailley Bert of the irrigation works undertaken for the relief of the inhabitants in the great famine of 1901 in the Presidency of Bombay. Here five camps were established where provision was made for 10,000 people who were engaged in the construction of a reservoir. To this camp came a mass of people of all ages and conditions, old men, women, and children, besides the actual work people, driven from their homes by misery and starvation. To deal with this multitude a complete system of feeding and hospital requirements, sanitation and the care of children had to be provided, while all the able-bodied were organised into an army of workers. The writer says that no description can correctly give an idea of the complete system of organisation and order of this installation, and he seemed to be greatly impressed with the fact that the whole management was carried out by native functionaries under the direction of a single English engineer, with the occasional visits of the collector of the district and his assistants.

It is pointed out in the article that irrigation, besides providing a means of meeting the sterility due to the absence of rain, adds very greatly to the fertility of the land, in some cases doubling, and in others increasing the yield fourfold, and increasing the value of the land from 2*l.* or 3*l.* an acre to ten or twelve times that amount. Irrigation also permits the cultivation of the more valuable crops, such as rice, wheat, sugar cane, and indigo, and it also leads to other works which assist in the mitigation of famines, such as roads and railways for the conveyance of the produce of the irrigated lands.

The Indian Government has already expended upwards of 23 millions sterling on irrigation works, providing water for 13 millions of acres at an average cost of 35*s.* an acre.

SOUTH AFRICA.

At the meeting of the South African Science Association held in May last, amongst other subjects discussed, the most important in the interests of the country was that relating to irrigation, which Sir Charles Metcalfe described as the most prominent question of the day. In a paper read by Mr. Westhofen, the author stated that, owing to the insufficiency and uncertainty in the distribution of the rainfall, it was absolutely necessary that irrigation should be resorted to if the country is ever to be made a self-supporting one. Thousands of square miles of the most fertile land are lying waste owing to the want of this most essential adjunct to agriculture. The institution of a proper system of irrigation has hitherto been hindered by want of capital, want of experience, and ignorance of the best methods of storing water and applying it to the greatest advantage. Irrigation is no new thing in Africa. In Rhodesia there exist the remains of ancient works, and for miles and miles may be seen the traces of skilfully engineered irrigation canals. No information exists as to who carried out these works. In a rude way the natives of the Zambesi at the present day obtain from two to three crops off their land by employing a simple system of irrigation. As an example of what might be done, and as a public object lesson, a large reservoir containing 1000 million gallons of water was constructed by Mr. Rhodes at Matapos, the water in which is held up by an earthwork dam 100 feet high.

While thousands of acres of fertile land are lying waste in Africa for want of irrigation, food to the value of 2¼ millions of pounds is imported through Cape Town.

Before an efficient system of irrigation can be organised, legislation is required to define the water rights. Sir W. Willcocks, in his report on the subject, suggested that all rivers and streams should be proclaimed as public domain and become the property of the nation.

The forestry of the country was also dealt with in a paper by Mr. D. E. Hutchins, who showed that while at one time there is evidence that Africa was a well-wooded country, the forests of to-day consist generally of nothing but stunted evergreen trees confined to sheltered kloofs. There are now, however, Government forests worked systematically by the Forest Department, but so scarce is the supply that the imports of commercial timber amount to half a million pounds. It was stated that the special sleeper plantations established by the Cape Government Railways cost 60,000*l.*, and that in twenty-five years they were estimated to bring in a revenue of 100,000*l.* a year. There is no doubt that the encouragement of the growth of forests will have a material effect in conserving the rainfall of the country.

NEW MEXICO.

In the report issued by the New Mexico College of Agriculture for April, an account is given of the experiments carried out for pumping water for irrigation from wells. New Mexico has a genial climate and fertile soil, but the amount of rainfall is light, averaging not more than from 8 to 16 inches a year. Irrigation, therefore, becomes a necessity. It was with a view to demonstrate the practicability of providing such a supply of water from the underflow that the experimental work was undertaken. The strata consist of sand and gravel, with occasional layers of clay. The Rio Grande Valley is underlaid with gravel beds sufficiently thick to procure from them an ample supply of water at a depth of from 20 to 80 feet. There are two methods of obtaining water from the underground supply. One by sinking a well down to the water-level, and then forcing perforated pipes to some depth below this. The experimental station well was sunk 48 feet deep, with six-

inch pipes driven 21½ feet below this. The other method is by driving tubes varying from 3 to 6 inches diameter down from the surface some distance into the water-bearing surface. With tube wells as small as 3 inches in diameter, the perforated portion at the lower end is driven with the pipe, but with larger tubes the open pipe is first sunk, and the strainer or perforated part lowered inside; the tube is then jacked up until the perforated tube is exposed. The pipes are sunk by means of a sand bucket, which consists of a cylinder 3 to 5 feet long, the diameter being a little smaller than that of the tube, provided with a plunger and valve at the bottom. The cylinder is forced into the ground, and then the plunger is driven down to the bottom, and when drawn up sucks the sand and small stones into it. It is then raised to the surface and emptied. In some cases pressure has to be exerted by means of weights or levers to force the bucket down, and it is continually turned round by means of clamps. In favourable ground it will sink at the rate of 1 foot a minute. Owing to the quantity of fine sand in suspension in the water, centrifugal pumps for lifting the water were found to answer best. Where wells are used the suction pipe draws from the water at the bottom, but with tube wells the suction pipe is attached to the top of the tube.

FORESTRY IN THE UNITED STATES.

THE bulletins, professional and hydrographical papers, which form part of the serial publications of the United States Geological Survey, treat of a variety of subjects, among which forestry figures conspicuously. Five beautifully illustrated volumes, accompanied by carefully prepared and coloured maps, have recently been received. The statistics and information collected from various sources by well-trained experts and specialists are put forth in a very plain and comprehensive manner.

The first paper is by Mr. Henry Gannett, and treats of the forests of Oregon. It deals very concisely with the composition and character of the different forests and woodlands in the State. At the outset a land classification table is given, which shows total area, merchantable timber area, open country, burned, cut, and barren areas.

As the author remarks, "the most startling feature shown by the land classification map of this State, is the extent of the burned areas." A point worthy of note, to which the author directs attention, is that "the burns are greatest and most frequent in the most moist and heavily timbered parts of the State, and are smaller and fewer where the rainfall is less and where the timber is lighter," the reason being that the density and abundance of the undergrowth forms excellent fuel for the fire, and vastly increases its heat and destructiveness. Of the total timbered areas, not less than 18 per cent. has been thus destroyed. This represents a total of 54,000 million feet in the State, with an estimated value of 54 million dollars, which the author very truly remarks is too much to lose through carelessness. However, as the region of the fire area is well watered, reafforestation appears to be progressing favourably, especially where the burns have not been extensive; but, where many square miles have been involved, the lack of seed has retarded the process considerably. The dangerous fire season is autumn, when most things are dry. However, the magnitude of such devastations appears to have been worse prior to and during the days of early settlement—from 1843 to 1870. The rest of the paper consists of extremely valuable notes accompanied by tables which give a classification of the lands together with the amount and classification of timber for each county in the State. There is no extraneous matter brought in—each sentence is pithy and to the point. The text, accompanied as it is by illustrations and maps, gives as perfect an idea of the character and stand of the timber of Oregon as can well be conceived.

The next professional paper (No. 2) of the series is by the same author. It deals with a revision of the estimates of the standing timber and its distribution in the State of Washington. These forests consist mainly of red fir (*Pseudotsuga taxifolia*), mingled with spruce, hemlock, and cedar. They are the densest, heaviest, and most continuous in the States, with the exception of the red wood forests of California. The author's general description is followed by a summary of the standing timber in Washington, after which each county is taken up separately and in detail.

The revised estimate shows an increase over that given in a former report; this is due to the inclusion of species which have now come into use, and also such species as are of known value though at present not utilised.

The next report (No. 3) of the series is by Mr. Fred G. Plummer. It deals with the forest conditions in that part of the Cascade Range lying between the Mount Rainier and Washington Forest Reserve. The land classification map which accompanies this report covers 2,800,000 acres, but after deducting the naturally timberless areas, such as arid lands, lakes, and glaciers, also the area destroyed by fire (8 per cent.) and logging (1·64 per cent.), there remains an area of 2,292,820 acres which can be called timber lands. After dealing with general matters, the author gives a list of trees and shrubs of central Washington, which is followed by a very useful and instructive table showing the distribution of species by zones of altitude. Then comes a detailed record of the amount of vegetable growth supported by an acre of average soil of the Cascade Mountains. The defects and diseases of timber trees, also the market prices of lumber, receive due attention. The bulk of the report is taken up with detailed descriptions of the various watershed areas. At the end of the paper irrigation, grazing, and mineral springs are reported upon. The author's remarks on irrigation are interesting, as they show what can be done in the way of reclaiming and utilising arid tracts for agricultural purposes.

Report No. 4 of the series deals with the conditions of the Olympic Forest Reserve, Washington, and has been prepared from field notes taken by Messrs. Arthur Dodwell and Theodore F. Rixon. It deals first with topographical matters, agricultural lands, stand of timber, timber trees, forest fires, mining, roads, &c. The principal part of the report gives a detailed description of the various townships contained in the forest reserve. There is much useful information regarding the accessibility of the forests and the facilities of timber transport, which are matters of considerable importance.

The forest conditions in the northern part of Sierra Nevada, by John B. Leiberg, form the fifth paper of the series. This report deals with the topographical features of the region examined, along with the extent and composition of the forest and woodland. The distribution of the various coniferous trees and forest type presented by each receive adequate attention from a sylvicultural point of view. The topographical, agricultural, and sylvicultural aspects of the various river basins are then taken up and described in detail.

In addition to the above, three volumes on forestry, each consisting of several papers, have already been published in former annual reports of the United States Geological Survey.

We have only been able to sketch in the briefest outline the scope and significance of the above works, which represent several years of painstaking and accurate investigation. The undertaking shows that the great importance of the forest is now duly recognised in America, although not so many years have elapsed since forestry was a comparatively unknown science in that country.

In the days of early settlement axe and fire were indiscriminately employed to the great destruction of the forest, and in later days, when timber was required for structural purposes, lumbering operations were so diligently and recklessly pursued in the most accessible forests that in a short time they were depleted of all but the most worthless material. He who wants a vivid description of this state of affairs need only refer to Prof. Heinrich Mayr's work, "Die Waldungen von Nord America," which contains a great amount of information and good advice as regards the conservation of the North American forests. We are glad to see such advice has now been accepted. The good work already done by the Geological Survey will form a basis upon which future schemes of management for the conservation of the forests of North America may be built.

THE VIENNA ACADEMY OF SCIENCES.

WE have lately received the *Proceedings* (vol. cxi.) of the Imperial Academy of Sciences at Vienna (*Sitzungsberichte der kaiserlichen Akademie der Wissenschaften*) for part of 1902. The volume is an important publication now, and is divided into four sections, dealing with different branches of the natural and physical sciences.

Section i. (April to July) includes mineralogy, crystallography, botany, physiology of plants, zoology, palæontology, geology, physical geography, and travels. We notice several important papers on systematic zoology and botany; by F. Siebenrock, on Podocnemis, Wagl., a genus of tortoises; by A. Zahlbruckner, on Brazilian Lichens; by E. Lampa, on liverworts; and by A. Attems, on the Myriopoda of Crete. There are also papers by O. Richter, on magnesium in its relation to plants; by F. Pischinger, on the structure and regeneration of the assimilative apparatus of Streptocarpus and Monophyllæa; by A. Abel, on asymmetry in the skulls of the toothed whales; by H. Hofer, on petroleum; and by F. Berwerth, on the structure of a meteorite from Mukerop, German West Africa; and several other papers, chiefly dealing with geology and palæontology.

In section ii*a*. (May to July), devoted to mathematics, astronomy, physics, meteorology, and mechanics, we have a large number of important papers, of which those relating to meteorology are perhaps of most general interest, such as those by J. Haan, on the meteorology of the equator, from observations taken at the Museum Goeldi at Para; by F. M. Exner, on the variations of the pressure of the air from day to day; and by J. Valentin, on the fall of dust between March 9–12, 1901. There are also several interesting papers on electricity, magnetism, photography, &c., as well as on mechanics and applied mathematics.

Section ii*b*. (April to July) includes chemistry, and comprises a large number of papers by various writers, among which we notice one, by R. von Hasslinger, on the formation of artificial diamonds by the fusion of silicates.

Section iii. (January to December) deals with the anatomy and physiology of men and animals, and also with theoretical medicine. There are only a few papers of importance in this section; by C. Storel, on caseine in asses' milk; by F. Winkler, on the infiltration of the vessels of the skin, when stimulated by heat; by F. Ballner, on the disinfective effect of saturated vapour of water at different boiling points; by O. Löw, on the chemiotaxis of spermatozoa in the female genital tract; by S. von Schuhmacher, on the cardiac nerves of men and Mammalia; by K. Toldt, jun., on the development and structure of the zygoma in man; and by J. Seegen, on the influence of alcohol on the diastatic energy of the ferments of saliva and of the secretion of the pancreas; and also on the formation of sugar in liver preserved in alcohol.

This imperfect sketch may serve to illustrate the activity of Austrians in various branches of science, and it will also be seen that, while the separation of the journal into sections is convenient, it can only be rough and imperfect, for the various sciences trench upon each other to such an extent that many papers might almost as well be referred to a different section to those in which they have been with equal propriety placed; thus a paper on organic chemistry would not be out of place in the section on physiology, or perhaps even zoology or botany, and so in other instances.

We may also direct attention to another point. All the papers in this volume (apart from their publication in it) are separately priced, and can be bought separately. In Britain, except where a paper fills the whole of a part, this is not the case, and separate papers are only furnished to authors to give away, on the tacit understanding that they are not to be sold. Perhaps this is sufficient for British needs, owing to the much smaller number of students who are engaged in special scientific work in Britain, as compared with German-speaking countries.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ON more than one occasion it has been pointed out in these columns that the study of economic botany is neglected by our universities and colleges. But though educational authorities have failed to make provision for students and research in economic botany, Kew has long been a training school from which men have been sent to all parts of the world, and a centre of expert advice on vegetable products. For thirty years or more a course of lectures on economic botany, intended to prepare men for service in India and the colonies, has been given in the museums of the Royal Botanic Gardens, Kew; and the course just finished, by Mr. J. M. Hillier, the keeper was attended by twenty gardeners in training. It is desirable that the study of vegetable economics should be encouraged in great commercial centres such as Glasgow, Liverpool and Belfast, as suggested by Prof. Bower in an address referred to in NATURE of December 18, 1902 (vol. lxvii. p. 165); but it must not be forgotten that, while universities and educational authorities have practically ignored the subject, Kew has been steadily training practical botanists and investigators for botanic gardens and other establishments at home and abroad. As a result there is now scarcely a botanic garden in India and the colonies which has not on its staff one or more men trained at Kew or recommended by the director of the Royal Gardens. Kew affords facilities for scientific and technical training in botany unequalled by any other institution, and it is satisfactory to know that so many members of the staffs of our botanic gardens have been trained there.

WE have received two publications from the United States concerning the education of deaf children. One pamphlet is the sixth report of the home in Philadelphia for the training in speech of deaf children before they are of school age, and the other is a special report, by the superintendent of schools, of the school for the deaf and the normal training department for teachers of the deaf in connection with the Board of Education of the City of Detroit. These booklets show clearly enough that it is quite possible so to educate deaf children that they can understand ordinary speech, and so work satisfactorily with normal persons.

WE have received a copy of the report of Prof. Starling, the Dean of the Faculty of Science of University College, London. The report was read at the assembly of the Faculties of Arts and Laws and of Science which took place in July last, and reference was made to it in our issue for July 9. Referring to the amount of scientific research done at University College, Prof. Starling says:—"I believe I may safely assert that in no university does the quality and the quantity of the original work turned out exceed that which we have to record at University College. Our success in this direction is attested by the continued increase in the number of research students, that is, of men of the highest ability who are seeking the best form of training for their subsequent careers. Whereas last year we had seventy-two research students, this year we have eighty-seven on our books. These men are drawn from all parts of the world, the British Isles, colonies of Canada, Australia and South Africa, and our Indian dependencies, Japan, Germany, Switzerland, and so on. Much of the work which they have turned out represents important advances in our knowledge, and will be of lasting value. It is satisfactory to know that, whereas a few years back all our best students and we ourselves regarded a visit to Germany as a necessary part of a science curriculum, the conditions are now beginning to be reversed." The list of original papers and other publications from the scientific departments of University College during the past year, with which the report concludes, contains more than a hundred entries.

A BLUE-BOOK showing the amount spent on technical education by local authorities in England and Wales, with the exception of five which have made no return, during the year 1901–2 has been issued by the Board of Education. The return shows that the total amount thus expended on technical education in England and Wales during the year 1901–2 was 1,057,399*l*. This amount is exclusive of the sums allocated to intermediate and technical education under the Welsh Intermediate Education Act, 1889. The amount raised by loan on the security of the local rate under the Technical Instruction Acts was 206,426*l*., the amount of loans, so raised, outstanding was 1,030,952*l*., and the balance in hand of moneys received and allocated to technical instruction was 658,319*l*. 16*s*.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, July 20.—The Rev. Prof. Flint in the chair.—An obituary notice of Prof. Cremona, by Prof. **Blaserna,** was communicated by Prof. Chrystal.—Mr. James **Russell** read a paper on the molecular condition of iron, demagnetised by various methods, in which a large number of experiments on the mutual effects of superposed magnetisations were described and discussed in the light of the molecular theory which had suggested them. According to the author's view, when iron has been demagnetised by a series of reversals diminishing by very small steps, the molecules in any small region, instead of being left in a condition in which as many point one way as another, are left with a preponderance pointing uniformly round the equatorial belt at right angles to the direction in which the magnetising forces had been applied. It is obvious that if a new magnetic force be applied codirectional with, or perpendicular to, the direction of the original set of forces, there will be no induction at right angles to the new force. But if the new force be applied in any other direction, there will be a component of induction perpendicular to this direction. The consideration of the theory in various combinations led to results which were tested by experiment. In all cases the theory stood the test of experiment satisfactorily.—Dr. D. Fraser **Harris** read a paper on affectability and functional inertia as the two fundamental properties of protoplasm. These were regarded as the two physiologically opposite functional capabilities, the degree of the relative intensities of which determined the particular manifestation at the moment. As examples of manifestation of functional inertia were mentioned insusceptibility, automatism, heredity, rhythmicality of action, the manner in which functional exhaustion was warded off and the state of fatigue substituted, &c. Functional inertia not only accounted for vestigial organs, but also for vestigial metabolism, as, *e.g.* the formation of uric acid in the mammal, an avian or reptilian metabolic relic.—Dr. Noel **Paton** communicated a paper on October salmon in the sea, in which some new points in the life-history of these fish were brought to light. In late runs of salmon male fish markedly preponderated. In the series studied, ovaries in all stages of development were found, so that ripeness of ovary was not the determining factor of migration from sea to river. One fish which had been obtained was of peculiar interest. In its strong mandible and large teeth it resembled a male, but when the viscera were exposed ovaries were found. The ovaries were flabby and soft, and had a yellowish opaque appearance, with pale opaque patches on many of the eggs.—In a note on resistance change accompanying transverse magnetisation in nickel wire, Prof. C. G. **Knott** and Mr. P. **Ross** described an experiment which seemed to show that in nickel wire in strong fields (in moderate fields in which the effect of longitudinal magnetisation is easily observed there is no measurable effect) there is very slight effect until a field of nearly 2000 units is reached, when the resistance begins rapidly to decrease, and goes on decreasing linearly with increase of current to fields of 5000. When the coil is wound with a pitch of 1 in 20, the component of the field along the wire gives rise to an increase of resistance which in the lower fields may counterbalance the slight decrease due to the transverse field. In the higher fields, however, this longitudinal effect is of comparatively small account. —Mr. J. H. Maclagan **Wedderburn** communicated a paper on the application of quaternions in the theory of differential equations.—In a note on a method of bringing together the two spectra produced by the ordinary spectrophotometer, Mr. J. R. **Milne** described a neat application of the well-known heliometric device of the divided lens. By using a divided lens in the eye-piece, he was able not only to bring the two spectra edge to edge without intervening dark space, but was able to shift the spectra sideways relatively to one another so as to compare directly the luminosities of strips belonging to different parts of the spectrum.—A paper by Dr. Thomas **Muir** on the theory of axisymmetric determinants in the historical order of development up to 1841 was also communicated.

PARIS.

Academy of Sciences, August 17.—M. Albert Gaudry in the chair.—Spectroscopic observations of the Borrelly comet (1903 *c*), by M. H. **Deslandres.** The spectrum obtained with an exposure of two hours is nearly identical with that of the comet 1893 *b* (Rordame). The bands due to hydrocarbons and cyanogen are clearly made out, and from the nature of the cyanogen bands it is concluded that the illumination of this gas on the comet is due to electrical phenomena.—On the aërodynamical phenomena produced by the cannon used in dispersing hailstorms, by M. J. **Violle.**—Examples of the mechanical analysis of soils, by M. Th. **Schlœsing,** sen. Examples are given of the mechanical analysis of soils by the method described in a previous paper. It is shown that the amount of clay does not interfere, and that analyses of the same earth, repeated under different conditions, give concordant results.—On the relation of the work of S. Lie to that of Liouville, by M. N. **Saltykow.**—On entire functions of zero order, by M. Edm. **Maillet.**—On the integrals of Fourier-Cauchy, by M. Carl **Störmer.**—A diagram giving the properties of nickel-steels, by M. Léon **Guillet.** The diagram is constructed with percentages of carbon as abscissæ, and percentages of nickel as ordinates. The diagram is divided into four areas, and allows of the deduction of the structure and mechanical properties of the steel from its composition.—On unsymmetrical tetramethyl-di-amino-diphenylene-phenyl-methane and related dye-stuffs, by MM. A. **Guyot** and M. **Granderye.**—A fixing liquid isotonic with sea-water, by M. M. C. **Dekhuyzen.** The solution is made up of a 2·5 per cent. solution of potassium bichromate in sea-water, 25c.c. of normal nitric acid, and 54c.c. of a 2 per cent. solution of osmic acid.—On the presence of lactic acid in the muscles of the invertebrates and the lower vertebrates, by M. Jean **Gautrelet.**—On the presence of microsporidia of the genus Thelohania in insects, by M. Edmond **Hesse.**—On the post-embryonic development of Ixodes, by M. A. **Bonnet.**

CONTENTS.

THURSDAY, SEPTEMBER 3, 1903.

PSYCHOMETRIC OBSERVATIONS IN MURRAY ISLAND.

Reports of the Cambridge Anthropological Expedition to Torres Straits. Vol. ii., Physiology and Psychology. Part i., Vision. Pp. vi+140. By W. H. R. Rivers, with an appendix by C. G. Seligmann. Part ii., Hearing, Smell, Taste, Cutaneous Sensations, Muscular Sense, Reaction-Times. By C. S. Myers and W. McDougall. Pp. 141–223. (Cambridge: University Press, 1901, 1903.)

IN his short preface to this second volume of the Cambridge anthropological reports, Dr. Haddon remarks that no investigation of a race of people can be considered as complete unless it embraces observations on such psychological phenomena as admit of definite determination. In order to carry this into practice, he appears to have resolved that such branches of study should be efficiently dealt with in the second expedition to Torres Straits. Dr. Haddon is to be congratulated on having framed this comprehensive and truly scientific conception of ethnographical study, and he is further to be congratulated on having secured the services of such efficient psychological representatives as Dr. Rivers, Dr. Myers, and Dr. McDougall. The psychometric observations carried out by these gentlemen have, as was to be expected, been conducted on thoroughly sound lines, and the results described in the reports thus form not only an extremely valuable addition to anthropological knowledge, but an almost unique contribution to the physiology of the special senses. To Dr. Rivers in particular, special praise is due for the thoughtful care which he has bestowed upon the conduct of the inquiry, and for the way in which he has collated and presented the results.

The main part of the work was carried out in Murray Island, where the observers lived for four months. This island was originally selected by Dr. Haddon as being, in his judgment, particularly favourable for the study of a simple primitive people; it is out of the track of commerce, and its inhabitants still retain their simple natural characteristics; it is true that they have come into contact with missionaries and have acquired a certain knowledge of pidgin English, but this was found to be a distinct advantage from the point of view of the expedition, since it facilitated the establishment of a good understanding between the natives and the members of the expedition, besides enabling the observers to converse more freely with those selected for psychometric experiment. The limited population, 450 all told, was an obvious aid to the inquiry, and, judging from the reports, it appears doubtful if any other community, European or Polynesian, has been psychometrically investigated under more favourable conditions as regards both absence of disturbing factors and simplification of method.

The observations discussed in the reports are mainly those involving sensation, their scope being determined by the time at the disposal of the investigators, the available apparatus, and the nature of the individuals on whom the experiments were made. In the first part of the reports Dr. Rivers gives an account of various visual experiments chiefly made on the Murray islanders, but also carried out with the aid of Dr. Seligmann on some of the other small islands in Torres Straits. The chief points aimed at were the determination of visual acuity, of colour vision, and of visual spatial perception. As regards visual acuity, the most trustworthy test seemed to be the well-known E type method, which consists in determining at what distance a given size of this letter can be recognised; the letter was placed in various positions (sideways, upside down, &c.), and recognition was indicated by the observed person placing in a similar position a corresponding E on a card which he held in his hand. The conclusion arrived at by Dr. Rivers is that the visual acuity of the Torres Straits islanders is only slightly more pronounced than that of normal Europeans, and that probably this difference would disappear on taking into account the refractive errors, myopic and other, of the latter class. The unanimity with which travellers ascribe a high degree of visual acuity to savage races does not, therefore, mean that these races have organs which are abnormally sensitive to stimulation by light, but is related to the power of the primitive savage to make correct inferences from comparatively insignificant visual data. This power does not depend on a more perfect organ, but is associated with the close attention which the savage pays to the natural objects which surround him. Dr. Rivers appears to agree with Ranke in believing that this close attention to detail can be acquired by practice, but that in primitive races it is associated with lower mental development and with incapacity to feel any marked æsthetic interest or enjoyment even in scenes which the European regards as of great natural beauty.

A very large number of observations were made upon the extremely interesting phenomena of colour vision. It is well known that the references to colour in classical literature show a limited variety of colour nomenclature as compared with modern colour vocabularies. The view of Gladstone and others that this indicates a difference between the range of colour sensations of the ancients and those of their modern successors has, however, been generally rejected on the ground that sensations may have been undoubtedly experienced even when no special terminology has been framed in order to describe them. It appears, however, from the observations on the Murray islanders that it is precisely those colour sensations which are more or less defective for which there is no definite descriptive word, thus supporting Gladstone's views. In Murray Island 107 individuals were tested for colour, and it is remarkable that not a single case of red-green blindness could be detected, although in Europeans such defects amount to quite 4 per cent.

The colour vocabulary is largely framed from the names of such natural objects as force themselves on the attention; thus the word for "red" is derived from blood, that for "green" from the bile of the turtle, it being common knowledge that if the turtle's gall-bladder was accidentally opened in preparing the

animal for food, then the intensely green bile rendered all parts inedible; only one colour was named from the hue of a flower, in spite of the great variety which tropical flowers show. Points of equal interest are the indefinite character of the word used for "blue," this being applied indifferently to blue-green, dirty yellow, grey, &c., and the complete absence of any word for "brown," the language resembling in this respect Homeric Greek. The Murray islander recognised "red" far more distinctly than any other colour; yellow was the next most recognisable hue, "blue" could only be differentiated when in considerable strength, and brown was merely a dull-looking light.

In this connection the simple experiments made upon peripheral colour vision were extremely suggestive. It is well known that in the European the red-green visual field is the smallest, whilst the blue and yellow fields are far larger, but in the Murray islander the green field was distinctly the smallest, and the red field extended widely into the peripheral regions; the largest field of all was, however, the blue one, these colours being far better recognised with peripheral vision than in vision involving the central macula. Probably, as Dr. Rivers suggests, the defective stimulation of the macula by blue light may be related to the excess of yellow pigment present in the Papuan race, and would not be in itself a sign of defective retinal capacity for excitation by these rays.

Many other points of great interest are detailed in this part of the reports, colour contrast, after-images, visual perception of distance, binocular vision, capacity to bisect lines, capacity to compare the length of vertical with that of horizontal lines, susceptibility to such well-known visual illusions as those of Müller-Lyer, Zöllner's line displacements, &c. In regard to all these points there appears to be little, if any, difference between the Murray islander and the average European; the details of these experiments will well repay the reader, particularly as Dr. Rivers has presented the results and described the methods in such a manner that his account can interest those who have not especially devoted themselves to this kind of work.

The second part of the present volume of reports deals with other sensory phenomena. The investigation of hearing was undertaken by Dr. C. S. Myers; it was rendered difficult by the not infrequent presence of defects in the ears due to the now prohibited practice of deep diving for pearls. The experiments on the younger inhabitants were free from such hampering circumstances, and the results showed that, as compared with Europeans, both the acuity of hearing and the capacity to distinguish differences of tone were distinctly inferior in the case of the islanders; on the other hand, it is remarkable that the range, as estimated by modified Galton whistles, was at least as extensive in the islander as in the European. The investigation of the sensations of smell by Dr. Myers was also extremely difficult, owing to the great objections entertained by the islanders for this class of experiment, but it seems from such observations as could be made that there is no marked hyper-sensitiveness to olfactory stimulation in this primitive race as compared with Europeans.

Dr. Myers also made some limited experiments on tastes; a specially interesting feature brought out by these observations is the complete absence of any word to describe the extremely conspicuous gustatory sensation which we denote as "bitter," although it is certain that the sensation was experienced. In connection with this remarkable omission is the circumstance that, even in Europeans, there is considerable confusion as to the sensory significance of the qualities connoted by the word "bitter." Cutaneous sensations, muscular sense, &c., were undertaken by Dr. McDougall, and here there are some striking, but not unexpected, differences between the Murray islander and the European. In the former the sense of pure contact was twice as delicate as in the average Englishman, whilst the susceptibility to pain through pressure, &c., was far less pronounced. It is somewhat surprising, considering how unfamiliar the islanders were with the necessary procedure, to find that, as regards the estimation of different weights, the average least recognisable weight increment was actually smaller in their case than in the corresponding average of thirty Englishmen, being 3·2 per cent. as compared with 3·9 per cent.

Finally, the very important subject of reaction-time was undertaken by Dr. Myers, who gives most valuable details of the results of his observations. It appears that, as regards auditory reaction-time, the younger Murray islanders give results identical with the average young English townsmen, but that, as regards visual reaction-time, the Murray islanders give distinctly longer results. This lag becomes more perceptible when the attention is definitely fixed on the visual stimulus rather than the preconcerted movement, a procedure which always lengthens the reaction-time of Europeans, but which lengthened that of the islander comparatively more. Further, when the method of choice visual signal was used, involving a complexity of psychical conditions, then the increased lag became still more apparent. The reader is referred to the original for the very instructive and, from a psychological standpoint, most suggestive details of these observations.

In conclusion, the authors are to be heartily congratulated on the appearance of this work, which is a very important contribution to both physiology and psychology. The reports form a lasting memorial both of the activity of Cambridge anthropology and of the genuine character of the scientific spirit which now actuates those who study the various aspects of ethnography; the appearance of the remaining volumes promised by Dr. Haddon will be looked forward to with the greatest interest by a wide circle of biological students. F. G.

A REVISION OF PRINCIPLES.

The Principles of Mathematics. By Bertrand Russell, M.A. Vol. i. Pp. xxviii+534. (Cambridge: University Press, 1903.) Price 12s. 6d. net.

THE appearance of a book addressed equally to mathematicians and to philosophers, setting forth all the assistance which philosophy can afford in the shape of material for mathematics to work

with, is a remarkable event, and the fact that the criticism, pertinent and lucid as it is, of the work of the great Continental thinkers is adverse on many fundamental points should claim for it the patient consideration of both classes of students. We quote:—

"The distinction of philosophy and mathematics is broadly one of point of view: mathematics is constructive and deductive, philosophy is critical, and in a certain impersonal sense controversial. Wherever we have deductive reasoning, we have mathematics; but the principles of deduction, the recognition of indefinable entities, and the distinguishing between such entities, are the business of philosophy."

In answer to the question, "what is mathematics?" we are told that

"Pure Mathematics is the class of all propositions of the form 'p implies q' where p and q are propositions containing one or more variables, the same in the two propositions, and neither p nor q contains any constants except logical constants."

These logical constants are defined in terms of the fundamental concepts which mathematics accepts as indefinable; the philosophical discussion of the latter occupies part i. of this volume. The remaining six parts are devoted to the establishment of the main thesis, that what is ordinarily known as mathematics is deducible from these fundamental concepts by purely logical processes. This, of course, necessitates a philosophical account of the processes which are admissible; the carrying out of the deductions in their most abstract and rigorous form lies in the province of symbolic logic, and is reserved for the second volume.

The mathematical reader is recommended in the preface to pass over some of the more philosophical portions and begin at part iv., on "Order." We do not endorse this recommendation, for the exact establishment of the notion of order is one of the most tedious pieces of work that the mathematical philosopher has to do; besides, many of the preceding chapters are not only extremely interesting in themselves, but absolutely essential to a correct appreciation of the science of arithmetic subsequently developed. For example, a *number* will be found to be defined as a *class*.

Concerning the notion of class, some slight criticism may not be inappropriate. The distinction between class, class-concept, and concept of class, which is of fundamental importance to exact thinking, is made admirably clear, but the same cannot be said of what is necessary to constitute a class. A class may be defined either extensionally, by an enumeration of its terms, or intensionally, by the concept which denotes its terms. The former method seems applicable only to finite classes; we cannot agree with the author that it is logically, though not practically, applicable to infinite classes, unless some meaning is attached to the word "enumeration" different from what is ordinarily understood. On the other hand, the latter method implies that a class is defined by a predicate, and contains those terms of which the predicate is predicable; but this leads to an apparent contradiction which Mr. Russell has discovered; for consider the predicates which are not predicable of themselves, for example, humanity, which is not human; "not predicable of itself" seems to be a predicate defining a class of predicates, yet to suppose that this defining predicate either is, or is not, contained in that class, leads to a contradiction. A similar contradiction is reached when we consider the class whose terms are all the classes, each of which does not constitute as *one* a term of itself as *many*; for in attempting to form this class, at any stage the terms already obtained constitute a class which must be included as a new term, and so on. This may be compared with the attempt to sum a numerical series each of whose terms is the sum of all the preceding terms; the comparison does not completely explain the paradox, but suggests that a distinction should be made among infinite classes somewhat like that between convergence and divergence.

Leaving the logical side of the subject, we come to the first mathematical idea to be defined, that of number. It was formerly supposed that the notions of "1" and "+1" were fundamental, and that from them all other numbers could be defined. In the present work the number of terms in a class is defined, in a manner slightly differing from Peano's, as the class of all classes similar to the given class. Similarity depends on a one-one relation, which can be defined without reference to number, and indicates by Mr. Russell's "principle of abstraction" the possession of a common property which may be called the number. Various reasons are given for preferring this definition, one of the chief being the inclusion of the infinite numbers introduced by Cantor.

Part iii. deals with quantity and magnitude, between which a subtle distinction is drawn, and contains an introduction to the problems of infinity and continuity, which are to be more fully discussed in part v. Part iv. develops the difficult theory of order and Dedekind's theory of integers. The next part is necessarily based largely on the work of Cantor. To readers unacquainted with the "Mengenlehre," the introduction of transfinite numbers must appear rather startling, but this is perhaps partly due to an unusual weakness in the English language. It must be remembered that by a transfinite cardinal number is meant a certain kind of infiniteness of aggregate, the same number belonging to different aggregates which are similar in the preceding sense; and a transfinite ordinal number is another name for a type of infinite series, or of generating relation.

In the chapters on real numbers and irrationals, we approach controversial ground. The particular object which the arithmetisers of mathematics have here in view is to complete the series of rational numbers by the introduction, without any appeal to intuition, of other numbers, so as to satisfy the abstract definition of continuity. One consequence of this will be that it will then be possible to assign a real number to every point on a straight line. Three great thinkers —Dedekind, Weierstrass and Cantor—have done this, making their definitions of an irrational number depend upon the theory of *limits*. Their methods are explained and criticised, the chief objection being that

there is no adequate ground for assuming that a limit such as that of the series of rationals whose squares are less than 2 does really exist. Instead of this Mr. Russell defines a *segment* as a class of rationals less than a variable term of itself, and shows that segments possess all the usual properties of real numbers. This theory agrees very closely with Cantor's, the point of divergence being where Cantor appears to regard the rational number a as identical with the real number defined by the series $(a, a, a, \ldots)$ whereas Mr. Russell will not admit this. On the one hand it is obvious that the two concepts are as distinct as "man" and "featherless biped," and therefore cannot be identical; but, on the other hand, it seems unnecessary to insist too much on the distinction, because no confusion need arise from using the expression "a" in two different senses. Thus, if b is the irrational number defined as the series $(\ldots a_n, a_{n+1}, \ldots)$ we may write $b-a=(\ldots a_n-a, a_{n+1}-a, \ldots)$ and in this equation a is a series or so-called real number on the left and a rational number on the right. The conclusion is that the series of rational numbers cannot be completed exactly as it stands, but the rationals must first be replaced by series, or, if preferred, by segments, and then by means of other series the continuum of real numbers can be constructed.

Limitations of space forbid detailed comment on part vi., in which, incidentally, Euclid gets some rather hard knocks; and in the matter and motion of part vii. Newton's laws are condemned as confused, worthless, and wholly lacking in self-evidence, while we are told that force is a mathematical fiction, and velocity and acceleration must not be regarded as physical facts.

On the whole the book is very interesting, although somewhat too long. The presentation is admirably clear, and the seriousness of the style is relieved here and there by neatly turned bits of humour. It does not pretend to say the last word on any subject, and, indeed, bristles with unsolved difficulties, towards the correct solution of which a great step is undoubtedly made by its publication.

R. W. H. T. H.

ELECTROCHEMICAL ANALYSIS.

Quantitative Chemical Analysis by Electrolysis. By Prof. Classen. Translated by Bertram B. Boltwood. Pp. vii+315. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 12*s*. 6*d*. net.

ELECTROCHEMICAL methods of analysis are now coming into such general use on the Continent and in America, and to a smaller extent in this country, that chemists will be prepared to welcome the latest translation of Prof. Classen's "Quantitative Analyse durch Elektrolyse."

The translation is made from the fourth German edition published in 1897, but, as the translator has been allowed wide latitude by the author, he has brought the book well up to date, and we find several features in this book which are not in the German original.

In chapters xiii. and xiv., for example, which deal respectively with "measurements of current strength" and "sources of current," there are quite a number of new blocks, as, for example, Bredig's amperemanometer and the Weston ammeters and voltmeters. We also find several new diagrams in chapter xvi., which deals with the accessory apparatus employed in analysis. As a matter of fact, we think, considering that the book is devoted to electro-analysis, some of the apparatus described is rather superfluous. A quadrant electrometer is not usually to be found in a laboratory devoted to electro- or any other analysis, the description of such apparatus appertaining more to works on physics or perhaps on general electro-chemistry. In chapter xviii. the author gives details as to "arrangements for analysis." The details which are given refer mainly to the very thorough installations at Aachen, and two photo-plates of the laboratories, as they are at present, also one showing the former equipment of the private laboratory, are given. One cannot learn very much from these photographs, but they improve the appearance of the book, and incidentally give an idea of the large number of platinum basins which Prof. Classen possesses.

On p. 153 we come to the analytical portion of the book, the first metal dealt with being iron. For the analysis of iron there is no doubt that Classen's oxalate method is extremely satisfactory, and the analytical results obtained are generally very accurate. At the same time, as Kohn and others have shown, this is really due to a balancing of errors. The iron deposited always contains traces of carbon, but, on the other hand, there is usually a trace of iron left in the solution, and these two errors balance. Classen states that iron, when deposited from solutions containing citrates and tartrates, always contains carbon, but leaves it to be inferred that when oxalates are employed, the metal is deposited free from carbon. Prof. Classen employs the oxalate method not only for iron, but he uses it for almost every metal, very often, too, when other ways are vastly superior, and he seems very much afraid that someone else will take credit for the method, because in almost every case we find a bracket in which it is stated that this is the "method of the author." As a matter of fact, there are only a few cases in which the employment of oxalates has any real advantage, as *e.g.* with iron and zinc. There is certainly nothing to be gained by using it when depositing copper, nickel, or mercury, where there are many much more satisfactory methods. Cobalt, according to the author, when deposited, shows its characteristic metallic properties. Generally speaking, when electrically deposited, cobalt is brownish or smoky in appearance—are these its characteristic metallic properties?

Section ii. of the analytical portion deals with the analysis of nitrates, and section iii. with the determination of the halogens.

Section iv., on the separation of the metals, is perhaps one of the best parts of the book. It may be very easy, and generally is, provided one employs the correct conditions, to analyse from pure salts of the metals, but the electrolytic separation of metals is

not always so simple. Of course, the chief point is to know how and when to combine pure analytical with electro-analytical methods in such a way as to attain the greatest accuracy, and to save as much time as possible.

Section v. is devoted to a short account of a very neat method of determining the halogens in presence of each other. It depends upon the fact that iodine is precipitated from its solutions at a lower potential than bromine. A silver anode is employed, and when at the lower potential all the iodine has been deposited, a fresh anode is placed in the solution, and a higher E.M.F. employed. Part iii. of the book is divided into two sections, the first of which gives some examples of applied electrochemical analysis, as *e.g.* analysis of alloys, such as brass, solder, type metal, &c., and of certain ores, such as cinnabar and molybdenite. The second section gives details for the preparation of reagents.

The book in its present form is a very useful addition to laboratory text-books. The introduction is, perhaps, rather unnecessarily long, but it explains Faraday's and Ohm's laws clearly, and gives a good general account of the theories of electrolysis. At the heads of the chapters very full references to the literature of the subject are given; the references are mainly to German and American authors, the reason being that Germans and Americans have done most of the work.

The translator, Dr. Bertram Boltwood, has carried out his labour with care and discretion, and many of his additions are very valuable. The book is splendidly printed, and the diagrams are very clear and well produced.

F. Mollwo Perkin.

TECTONICS OF THE EASTERN ALPS.

The Geological Structure of Monzoni and Fassa. By Maria M. Ogilvie-Gordon, D.Sc., Ph.D. Pp. x + 180. (Edinburgh: For the Geological Society of Edinburgh, Turnbull and Spears; London: Simpkin, Marshall and Co., Ltd., 1902–3.)

It is indeed satisfactory that the Geological Society of Edinburgh has, with considerable enterprise, published the very detailed observations of Dr. Maria Ogilvie-Gordon. We can easily conceive that, when originally presented to the Royal Society of London, this paper seemed of somewhat local application (prefatory note, p. v.), and it is the privilege of societies with fewer claims upon their funds to do justice to the work of their own members. It rests with the author to see that the circulation of separate copies is judiciously carried out, in which case, from a cosmopolitan point of view, the place of publication has little influence on the judgment of scientific men.

One feels, however, that continuous energy and persistent attention to detail on the part of Dr. Ogilvie-Gordon have brought into an important controversy a feature that may be superficial, but which, none the less, jars upon the reader. One becomes inclined to believe that an observation claims our notice because it was made by the authoress, and not because it furnishes a link in the long chain of argument. The same impression, it is true, is often produced in the works of Ruskin or Carlyle, but does not form their most enduring attraction for posterity. The recognition of Dr. Ogilvie-Gordon's work is manifest from the frequent references to it by Continental writers, notably in the new "Führer für die Exkursionen," issued for the ninth Geological Congress in Vienna. Yet we cannot forget that the authoress attaches so much importance to the views adopted by her as to have introduced disparaging remarks upon a rival school in the "translation" of a work by Prof. von Zittel. The paper now before us the record of some years of devoted and faithful study in the field, describes how the Triassic masses have been broken up by a double series of planes of fracture, along which igneous rocks have crept during the period of earth-movement. Possibly, then, there is some appropriateness in a mode of treatment which causes us to see the lines of weakness in previous descriptions penetrated with an almost intrusive pertinacity.

Not that there is any note of battle in the present treatise. The authoress gives her reading of the very numerous observations made by her in a classic area, and the difficulties to be faced are well realised by Doelter in the "Führer" above referred to, when he says of Predazzo,

"Die Teilnehmer an dieser Exkursion betreten ein Gebiet, welches zu den allerinteressanten Europas gehört, aber auch zu denen, wo der Zwiespalt der Meinungen am grössten ist. Die verschiedensten und widersprechendsten Ansichten haben hier geherrscht und herrschen teilweise heute noch."

Similar caution is shown by Drs. Diener and Arthaber in treating of the "reef-facies" in the Schlern area. With regard to the causes that bring massive limestones into juxtaposition with normal sediments, along surfaces that occasionally interlock, all geologists are aware that Dr. Ogilvie-Gordon has adopted a theory of cross-fracture and faulting (p. 67), and has done so after detailed mapping on the ground. Her views of the Monzoni mass are admirably stated on p. 176 of the present paper.

"I therefore strongly insist upon my observation in the case of Monzoni that the particular band of limestone strata entered by the sill was at the time of inflow *in process of sinking* steeply inward at the inthrow faults . . . While the ascending magma involved and engulfed fragmentary portions of the insinking calcareous rock, it clearly found easiest access amidst the multiplicity of fracture and shear-slip planes in the body of Werfen strata to the south."

The succession of intrusions is then described, and the suggestive conclusion is arrived at (p. 177) that

"during the geological periods when the fault-vent continued intermittently active, the form of the sill-complex was capable of being re-moulded periodically in harmony with the localised crust-stresses."

The Cainozoic age often assigned to the whole eruptive series of Monzoni, which can only be proved to be later than the Lower Trias, is not a vital point in Dr. Ogilvie-Gordon's paper. Its interest lies in its tectonic details, and these are illustrated by a number

of coloured sections and two folding maps. Some of the photographic plates, such as that of the "block-structure" in porphyrite, facing p. 106, are of unusual beauty. G. A. J. C.

OUR BOOK SHELF.

A. Koelliker's Handbuch der Gewebelehre des Menschen. 6te Auflage. Drittes Band. Von Victor v. Ebner. Pp. 1020; 633 illustrations. (Leipzig: W. Engelmann, 1902.) Price 18s. net.

THE conclusion of the sixth edition of Koelliker's "Histology" merits more than a passing remark. The first appearance of this well-known handbook about the middle of the last century formed an epoch in the science of which it treats (which it may almost be said to have created), and ever since it has held the foremost rank in works dealing with the subject. But it is now more than thirty years ago that the fifth edition was published, and progress has been rapid in the interval.

The first two volumes of the present edition were edited by the original author, and no work that he has done has been better done than this. But the weight of years must eventually tell, even if one is Koelliker, and the task of editing the third volume was handed over by him to Prof. v. Ebner. A first part of this volume, dealing with the digestive, respiratory, and urinary organs has appeared, and has already been noticed in NATURE; the last part of the work, embracing the structure of the generative organs, the vascular system and the organs of special sense, and comprising also an index of subjects and authors for the whole book, is now in the hands of histologists. Prof. Koelliker's selection of an editor for his great work is amply justified; a better successor to himself could hardly have been found than the eminent Vienna histologist, who has, moreover, been ably assisted by Dr. Joseph Schaffer and Dr. Hans Rabl. It is to all intents and purposes a new book which has made its appearance. Hardly a page but has been rewritten, and of the 633 illustrations, 533 are entirely new—for the most part from original preparations. Nevertheless, the general style of the preceding volumes is singularly well carried out in this one, so that it is difficult at first to recognise that the work is by another hand. Too much praise cannot be given to the bibliographical notices, which are far more complete than are to be found in any other work on histology.

The whole book is a storehouse of information based on personal observations, and must long remain the standard work of reference on the subject.

The octogenarian master, whose own scientific activity is by no means exhausted, must be well content to know that his work has been brought to so brilliant a completion, and in presenting to him our respectful congratulations, we may be permitted to express the desire that he will still continue for many years to enjoy the satisfaction of witnessing the success of his life-long labours. E. A. S.

Building Superintendence. New edition, revised and rewritten. By T. M. Clark. Pp. 306. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 12s. 6d. net.

THIS is a book which appears to have had an extended circulation in the United States, and, although it contains a good deal of practical information, a large amount would only apply to construction methods on the North American Continent. It is primarily addressed to the young architect, and gives him hints as to the selection of good materials and as to the direction of building operations generally. A knowledge of building construction is therefore assumed, and the book is intended to supplement that knowledge by the practical application to existing buildings.

The subject is divided into three main heads, namely, stone buildings, wooden buildings, and steel-framed buildings, and in each case a typical building is described from the foundations upwards, showing the successive stages of construction and general direction for the judging of the quality of materials. The term "superintendent," which occurs so often, is presumably the American equivalent for the English clerk of works.

The English student should beware of information which may apply in the States, but is not correct as applied to England; for instance, on p. 5 we are told that five courses of bricks commonly equal one foot in height, whereas, as a matter of fact, four courses in England usually equal one foot. Many of the terms and names will also be quite unfamiliar to him.

Chapter i., dealing with stone buildings, takes up the construction of a stone church intended to be erected on elevated ground. This occupies more than 100 pages, and deals with the preliminary staking out of its various parts—foundations, damp in cellars, the making of concrete and mortar, defects common to various kinds of stone, walling, flooring, roofing beams, and plastering. The information is sometimes effected by means of question and answer between the architect and foreman in the manner made familiar in the treatises of Viollet le Duc.

Chapter ii. deals with wooden dwelling-houses, their location and aspect, drainage of site, employment of contractors, the framing of the timber (uprights and sills), chimneys, electric wiring and fitting, roof shingles, plastering, plumbing fittings, doors, windows, stairs and their arrangement and defects, drainage and water supply, and painting. Chapter iii., dealing with the writing of specifications, can be passed over, as essential differences exist between English and American practice. Chapter iv. deals with contracts, and the author rightly dwells on the importance of these, especially with regard to the necessity for protecting the building owner.

Chapter v. deals with the construction of a steel-frame office building, eleven storeys high, on a corner city site 25 feet by 100 feet, in which economy of space has to be carefully studied. This is probably one of the most interesting chapters in the book, and its construction is dealt with in a progressive way, in the same manner as in the stone and wood buildings.

The plan, question of fire escapes, foundation, steel framework, vaults, floors (fire-resisting), elevators, are dealt with in turn. As will be seen, the book is arranged on a sensible and convenient plan, and if it could be written to be suitable for English readers, it would be of greater benefit. As it is, however, it contains a great deal of excellent advice founded upon practical experience, and no architect could read it through without having his wits sharpened for discovering defects in workmanship at the periodical visits which he pays to buildings in course of erection from his designs.

A Key to the Time Allusions in the Divine Comedy of Dante Alighieri. By Gustave Pradeau. Pp. 32. (London: Methuen and Co., 1902.)

THE author, having found that different editions of the great poem of Dante assigned different durations of time for the action supposed to be occupied by it, set himself to investigate the matter by a comparison of all the time allusions until the poet ascends from over Jerusalem to the *primum mobile.* He ingeniously illustrates his argument by a diagram or "dial" in the circumference of which are the signs of the zodiac, whilst in the centre are four points representing respec-

tively Jerusalem, Purgatory, the Ganges, and Morocco. Dante imagined that, with respect to Jerusalem, the Ganges was the extreme east and Morocco the extreme west. The four important divisions of the day, *mezzodi* or midday, *sera* or evening, *mezzanotte* or midnight, and *mattino* or morning, are represented by lines towards the circumference. At the beginning of the poem Gerusalemme must be placed at the top of the circle, with Mattino over it. Now looking southwards, holding the dial straight before us, it will be found that the sun on the dial follows the same course as the real sun. The lines in the Inferno, Purgatorio, and Paradiso which contain the time allusions are given in Italian and in Longfellow's English translation, and the author finds that the whole duration from the beginning of the poem to the final morning in Purgatorio is seven and a half days, *i.e.* seven days from the entrance with Vergil into Hell.

The conceptions of great poets like Dante and Milton must ever be of interest, though we cannot, of course, expect them to be in agreement with modern astronomy. The latter, though constructing the universe according to Ptolemy, yet, living after Copernicus, and being personally acquainted with Galileo, evidently had misgivings with regard to the truth of that system. None such troubled the mind of Dante; to him the earth was the centre of the universe, both in appearance and in reality. But M. Pradeau presents a scheme concerning his views as bearing upon the progress of time in the "Divina Commedia" which is both ingenious and consistent with itself.

W. T. L.

A School Geometry. Part iii. By H. S. Hall, M.A., and F. H. Stevens, M.A. Pp. vii+137 to 210. (London: Macmillan and Co., Ltd., 1903.) Price 1s.

IN this volume we have a further instalment of the new text-book of elementary geometry which the authors have in preparation, a school geometry based on the recommendations of the Mathematical Association and the recently adopted report of the Cambridge Syndicate.

The present contribution deals with the geometry of the circle, and contains the substance of Euclid, book iii., 1–34, and a portion of book iv. The authors have omitted some of Euclid's propositions, and have not adhered strictly to Euclid's sequence, but the Euclidean form of proof has been retained.

The conception of a "limit" is appropriately introduced in explaining the nature of tangency, and in establishing some of the propositions.

The exercises, which follow the propositions at short intervals, are partly deductive and partly graphical, the latter requiring the use of compasses and scale, the numerical answers being collected at the end of the volume. The examples are simple and well graduated.

We consider that problem 23 would be better omitted, together with the exercises based thereon. It is of no practical value, and should be consigned to the Euclidean relics. Every draughtsman knows that a line can be drawn with greater accuracy to touch two given circles than to pass through two given points, and if the points of contact are wanted, they can be determined subsequently by drawing perpendiculars from the centres of the circles.

The circumference and area of a circle are briefly dealt with on p. 198. The experimental determination and verification of these quantities might with advantage have been more fully gone into. The book concludes with some propositions on circles and triangles, including a demonstration of the property of the nine-points circle.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

American Botanic Laboratory in Jamaica.

THE Director of Kew presents his compliments to the Editor of NATURE and requests the favour of his publishing the enclosed letter.

Kew, August 23.

Sir William Thiselton-Dyer,
Royal Botanic Gardens,
Kew,
Surrey, England.

My dear Sir,

The Government of Jamaica has decided to relinquish its use of the buildings at Cinchona. The experimental and botanical plantations are, however, to be maintained as before. The Surveyor-General of Jamaica offered under public advertisement on June 15 the group of buildings known as Bellevue and some land for rental. I have personally accepted this rental for the purpose of saving the station for scientific purposes, and with the plan of establishing there, if possible, the long desired botanical laboratory in the American tropics. At my request, Dr. MacDougal has recently visited Jamaica to arrange details of the lease, and reports that the buildings and their furnishings are already comfortable and well adapted for the use of investigators.

Dr. MacDougal and I decided to take these steps after consultation and correspondence with Prof. Underwood, who spent the early part of the year in Jamaica in the study of ferns, and who is now in Europe; with Dr. Duncan S. Johnson, who has recently returned from Jamaica, where he has been collecting material for embryological studies; with Mr. Wm. R. Maxon, who was with Prof. Underwood there during the spring; and with Prof. Earle, who spent last November in Jamaica in mycological investigations. Dr. MacDougal was already familiar with the locality from his visit there with Prof. Campbell in 1897, and we had discussed the topic with the Hon. Wm. Fawcett, director of the public gardens and plantations of Jamaica, while he was in New York last autumn during the meeting of the Plant Breeding Conference. The aid and cooperation of all who regard the securing of Cinchona as a proper and desirable act will be needed to maintain such a laboratory, and to this end I ask that you write me your opinions on this subject, and to indicate what aid you can render, and whether either you or your students would wish to make use of the station during the next year, and if so, for what length of time approximately.

I may say that the Jamaican Government is heartily in sympathy with the enterprise, and will cooperate to a very important extent, furnishing facilities for growing plants under the widely different climatic conditions offered by the gardens at Cinchona, Hope, and Castleton, the use of the large botanical laboratory and herbarium at Hope, and the use of visitors' tables in the laboratory at Hope.

As regards Cinchona, I quote the following from Prof. Underwood's account of his work in Jamaica from the July issue of the *Journal* of the New York Botanical Garden:—

"Not the least important of the results of the expedition was a possible solution of the problem of a suitable location for a tropical laboratory, which has long been under consideration by American botanists. At the time of the visit of the committee appointed some years ago to investigate the subject, the plant at Cinchona was occupied by the Government botanist, and was consequently out of the question. A one-story six-room house, three or four low buildings suitable for laboratory work, with two greenhouses of sufficient capacity to conduct experimental work under glass, could be had of the Jamaica Government at a nominal rent. Cinchona is nearly a mile above the sea, with a delightful climate (the extremes of temperature for the past twenty years being 45° F. and 79° F.), a delightful outlook, and as closely accessible to virgin forest as could be obtained. Within three miles, nearly on a level, is

Morce's Gap, whose tropical conditions I have described above; close to Morce's Gap you make the ascent to John Crow Peak (6000 feet), through a forest of tropical luxuriance. Below is Mabess River (3000 feet), with similar but lower-level vegetation. At about the same distance from Cinchona (three miles) is New Haven Gap (5500 feet), with a similar but higher-altitude flora. Still higher altitudes are accessible at Portland Gap and Blue Mountain Peak at a distance of eight to ten miles.

"There are no human habitations above Cinchona, so that the Clyde River, which supplies it with water, is pure and without sources of contamination; a more healthful location could not be found in all the American tropics."

Briefly expressed, the above scheme offers the investigator residence accommodations and laboratory facilities at Cinchona under the most pleasant and advantageous conditions, from which place he may quickly transfer his work to more pronounced tropical conditions at Hope in a dry climate; or to Castleton in an extremely humid locality. The marine flora is equally accessible.

The locality furnishes easy access to an immense number of species of plants different from those available at any other similar institution; travelling and living expenses are very reasonable, and Jamaica may be reached at intervals of only a few days by numerous steamers from England, Germany (Hamburg), and nearly all ports of eastern America.

Yours sincerely,
N. L. BRITTON.

New York Botanical Garden, Bronx Park,
New York City, August 13.

Training of Forest Officers.

IN a sympathetic notice in the *Indian Forester* of the late distinguished Inspector-General of Forests in India, Mr. H. C. Hill, Sir Dietrich Brandis stigmatises as "absurd" "the idea which, until a short time ago, was current in England, and which to this day is held by many English botanists, that a good botanist must necessarily be a good forester." I quite agree that the idea is absurd; but as I am probably better acquainted with the English botanical world than Sir Dietrich Brandis, I doubt very much whether the idea was ever current in this country, or is held at the moment by many English botanists. For my part I entirely dissociate myself from it, as I know many accomplished botanists who would probably make very indifferent forest officers.

I am more able to agree with Sir Dietrich Brandis when he says, "A forester, more than almost anybody else, must use his eyes and must be able on the spot to draw conclusions from what he has observed." But the power of observation is by no means possessed by everyone. A further requisite, in which I think Sir Dietrich Brandis also agrees, is sympathy with and pleasure in forest nature for its own sake. It appears to me that neither point is kept in view in the present mode of recruiting the Indian Forest Service.

Sir Dietrich Brandis lays great stress on sport, and unless it becomes too absorbing a pursuit, it undoubtedly fulfils the conditions I have stated. It would, however, be as undesirable to insist that every forest officer should be a sportsman as that he should be a botanist.

But I entertain a very strong opinion that a forest officer will never rise to the highest level of efficiency in his work unless he has a scientific grasp of the principles which underlie it. He should be able to identify the trees which compose the forest vegetation under his charge, and for this purpose he should have such an elementary acquaintance with botany as will enable him to use intelligently the book which Sir Dietrich Brandis has been for several years occupied at Kew in preparing for the purpose. He should further have some knowledge of the nature and conditions of vegetable life; he should grasp the idea that a tree is a living organism the growth and development of which are subject to adverse or favourable conditions. He should further have some idea of the enemies and diseases by which trees are liable to be attacked, and of how these attacks can be met. All this a man of ordinary intelligence can acquire if he possesses a real taste for nature without rising to the level of the professional botanist, which it would be absurd to demand of him.

There is the same fallacy underlying the view that mere administrative efficiency is sufficient for a good forest officer as in thinking that mere mechanical drill, without resource or initiative, will make a good soldier.

As I have felt it my duty to urge these views officially, I should be glad to state them more publicly.

I should like to take the opportunity of expressing my regret at the untimely death of Mr. H. C. Hill, the late Inspector-General. Largely as the result of my personal persuasion he accepted a mission in 1900 to initiate a scientific forest administration in the Straits Settlements. His reports were of the highest value, and will be a permanent basis for the future forest policy of that part of the Empire.

W. T. THISELTON-DYER.

Kew, August 28.

Peculiar Clouds.

CAN any of your correspondents explain the following phenomenon? At 5.20 p.m. to-day, the sky to the W. and S. being covered with a dense and unbroken mass of cloud, and the sun, therefore, entirely obscured, I saw a broad patch of iridescent colours like a piece of a rainbow on the clouds to N.N.E., many points more to N. than a rainbow would have been had the sun been shining. No part of the sky was clear, but the clouds were lighter in the N.W.

I saw a similar phenomenon at Colwyn Bay on December 17, 1898, the iridescent cloud being due E. at 2.45 p.m., the sun shining intermittently. I know true "iridescent clouds" well, but they are generally near the sun.

ALFRED O. WALKER.

Ulcombe, Maidstone, August 30.

THE EARTHQUAKE OBSERVATORY IN STRASSBURG.

NOW that the earthquake observatory in Strassburg has been offered as a centre for the proposed international association for seismological research, at which the work of the world so far as it bears upon earthquakes and kindred phenomena may be concentrated, a short description of this institution and its present output may not be devoid of interest.

The building stands in the back part of the University gardens, and lies between two streets, along which heavy traffic is forbidden. Externally it measures 19 x 15m., and essentially consists of four rooms, round the walls of which there is a passage or air space 1m. in width, walls, a second air space, and the outer walls. In short, it is a building with its floor 1·50m. below the surface, within two other buildings.

The object of the construction is to obtain rooms which are light tight, free from currents of air, and in which changes of temperature and moisture should be small. For certain classes of observations these conditions may be imperative, but when recording earthquakes, which is the chief work at Strassburg, gloom and a still atmosphere are distinctly undesirable. In the early days of seismometry the proper place for an earthquake recorder was considered to be a cellar, and when we find instruments with complicated parts which frequently require inspection, and which write their records on smoked paper, together with photographic apparatus designed to be used in broad daylight, relegated to darkness, we realise that traditions still survive.

Although it is well known that different results are obtained from similar instruments installed on different formations, the choice of site at Strassburg was apparently governed by the advantages offered by proximity to its University. In consequence of this, town traffic, which includes that of an electric service,

which might influence certain geophysical investigations, and the fact that alluvium might mask small tremors, are conditions that cannot be avoided.

In the *Beiträge zur Geophysik* (vi. Band, 3 Heft) issued "Zur Begrüssung der II. Internationalen Seismologischen Konferenz," Prof. Dr. Bruno Weigand gives an account of the instruments now in use at Strassburg Observatory, and an explanation of the monthly reports issued from the same.

The instruments longest in use are two Rebeur-Ehlert horizontal pendulums. In each instrument there are three pendulums arranged at angles of 120° with each other, the idea being that the three records would enable an observer to determine the direction in which an earthquake motion was propagated. Inasmuch as it has been well known for many years past that the movement of the ground as recorded at a given station may be in any azimuth, we are not surprised when Dr. Weigand tells us that no satisfactory result has been obtained.

The records are photographic, the source of light and the record receiving surface being at a distance of 5 metres from mirrors on the pendulums. This necessitates the use of powerful electric lamps. This condition, the high sensibility due to high multiplication of the instrument, which on certain foundations leads to wandering of the light spot, and the cost of photographic paper, which is run at the rate of 36cm. per hour, preclude the use of this instrument excepting at a few selected stations. Other instruments are Wiechert's astatic pendulum, Vicentini's microseismograph, and Omori's conical pendulum, all of which write on smoked paper, Milne's photographic horizontal pendulum, which is a type adopted by the British Association, and Schmidt's trifilar gravimeter.

Brief references to the records of these instruments are published in a *Monatsberichte*. All that this gives about the Strassburg records of an earthquake is a time for its commencement and its duration as recorded by a Von Rebeur pendulum. The times of maximum or other phases of motion, amplitudes, periods, and other information required by seismologists is omitted. A plus or minus sign indicates whether other instruments did or did not respond to the movement, and the latter signs predominate.

With the object of showing the superiority of the Strassburg type of instrument, particularly as compared with the type adopted by the British Association, which latter, according to his opinion, should cease to exist, Dr. Weigand emphasises the discrepancies between his various registers. As illustrative of the supposed want of sensibility in the British Association type, he points out that the Strassburg *Circular* for August, 1901, shows that the Rebeur pendulum recorded twenty-four earthquakes, whilst a British Association type, in the same building, only recorded seven. This latter number he now raises to ten. As a matter of fact, seventeen of the Strassburg records correspond with seventeen records obtained in Britain, whilst five entries in the Strassburg list refer to very small disturbances peculiar to that place, which therefore may well be regarded as being of doubtful origin. The earthquakes recorded in a given period by the Rebeur and British Association pendulums were therefore nineteen and seventeen. Dr. Weigand published these numbers as twenty-four and seven, and similar discrepancies between the records of the Rebeur pendulum and the records of all other instruments in use at Strassburg appear in each of the Strassburg registers.

That the Rebeur pendulums as installed at Strassburg have a higher sensibility than other seismographs is well known, but it must not be overlooked that this high sensibility is one factor which prevents their general adoption. That the British Association type of instrument is sufficient for the purposes for which it was intended is amply shown in the reports issued by the Association. Experiments are now in progress to increase the speed of the record receiving surface connected with this apparatus about four times, and to reduce the cost of photographic material to about 3*l.* per annum. It now costs 6*l.* 10*s.* per annum, whilst paper for the Rebeur apparatus costs 15*l.*

When Dr. Weigand complains of the want of sharpness in the trace yielded by the British Association instrument, he should evidently look to its adjustments, for it is its pronounced sharpness that compensates for its want of multiplication. In this respect the records it yields are far superior to those obtained from any other form of photographically recording seismograph.

That it should be affected like other instruments with so-called "Mikroseismische Unruhe" is what might be expected if located in a cellar.

Altogether, the institute at Strassburg as "der Kais. Hauptstation" might easily be improved, whilst if its publications took the form of the excellent registers issued in the *Bollettino della Societa Sismologica Italiana*, they would be of greater value to working seismologists.

THE INTERNATIONAL STUDY OF THE SEA.[1]

THE publications mentioned below are the first reports of the International Council for the Study of the Sea which was constituted by the meeting of representatives of the maritime Powers of northern Europe at Christiania in 1901, and now has its seat at Copenhagen. The bulletins deal with what has come to be known as hydrographic work carried out on the quarterly cruises, in which special ships of each of the participating States take part. The word hydrography is not, however, used in the sense made familiar by the hydrographic offices of the various Admiralties; it means, if we may borrow for a moment the terminology of chemistry, scarcely more than inorganic oceanography. We say scarcely more, for in these bulletins it does include the study of the distribution of plankton, but for this purpose plankton are treated rather as current-floats than as organisms.

It will be remembered that the International Council was formally constituted at a conference held at Copenhagen in July, 1902, and that no time was lost in getting to work is plain from the fact that the first number of the Bulletin deals with a series of cruises in August, 1902, the second with a similar series in November or December, 1902, and the third with February, 1903. These cruises have since been continued quarterly, and we understand that they are now more complete, and the results obtained more readily comparable than was possible when the collaboration was only beginning. Viewed from the standpoint of scientific efficiency, the work of the Council is hampered by the very short term for which the various Governments have granted the necessary funds and the stringent conditions as to endeavouring to obtain practical results directly beneficial to fisheries which have been insisted on in some cases. But there is reason to hope that these very difficulties will act as a spur.

The bulletins are mere records of observations, they contain a minimum of explanatory letterpress, and no discussion at all. It might be found desirable to print

[1] Conseil permanent international pour l'Exploration de la Mer. Bulletin des Résultats acquis pendant les courses périodiques. Publié par le Bureau du Conseil avec l'assistance de M. Knudsen, Chargé du Service Hydrographique Année 1902–1903. Nos. 1, 2 et 3. (Copenhague: A. F. Höst et Fils, 1903.)

a little more information, for instance, as to the constitution of the International Council and its administrative bureau, the address of the office and a brief statement of the objects for which the organisation has been brought into existence. The salient features of the maps of the physical conditions of the surface water might also be expressed in words, and the stations at which observations were made ought to be indicated on the map of each cruise by dots. We are inclined to lay stress on this point, as without some indication of the kind the maps are difficult to interpret, and the scale is not large enough to permit the figures of each observation to appear.

The August and November cruises were carried out in the Baltic by Finland, Sweden, Denmark, and Germany, in the North Sea by Germany and Scotland, and in the North Atlantic and Arctic Sea by Norway and Russia. To these there were added in February observations in the North Sea by Holland, and in the English Channel by England, England and Scotland being separately represented, mainly on account of the different nature of the fishery problems in their respective areas. It may be noted that these bulletins do not touch on the fishery observations, nor on the biological work (the determination of plankton excepted), which occupy the whole time of the various national staffs between the quarterly cruises. They do not refer either to the work of the Central Laboratory at Christiania.

The importance of the bulletin lies in the fact that it gives particulars of the temperature and salinity at a great number of points from latitude 45° to 75° N., observed nearly simultaneously and with comparable instruments of the highest precision, the temperature being determined by means of the Pettersson-Nansen insulating water-bottle and thermometers graduated to the fifth or even the tenth of a degree centigrade, the salinity by estimation of chlorine.

Both for August and November the central part of the North Sea appears to have been left without observations, but this gap was partly filled up in February when the system of quarterly cruises was more complete, and a number of supplementary observations by trading steamers had been added. The indications in the published maps are of a slight freshening along the British coast, a belt of maximum salinity running parallel to the coast towards the middle of the North Sea, increasing in salinity rapidly to the north-west between Scotland and Faeroe, and to the south-west towards the English Channel. The whole of the eastern half of the North Sea shows a rapid freshening towards a stream issuing from the Baltic close along the west coast of Jutland.

Where the temperature observations were sufficiently close and regular to permit of isotherms being drawn, they present a remarkable relation to the isohalines. In August the one isotherm shown is that of 12° C., which runs from Aberdeen to Lindesnaes, cutting the isohalines at right angles. In the November map, however, the isohalines and isotherms exhibit a most striking parallelism, so that the circulation of the water in that month could be studied with equal facility by considering either the temperature or the salinity. Thus at the southern end of the North Sea the isotherm of 13°.5 C. coincides with the isohaline of 35.25 per mille, and the isotherm of 13° C. with the isohaline of 35.00 per mille. At the mouth of the Baltic the two sets of lines though parallel do not correspond symmetrically, while on the north-west side of the Baltic stream 10° lies close to 34‰, on the east side it lies close to 32‰. Still the axis of the Baltic stream is the same whether it is drawn from the one set of lines or the other.

The February map shows the isotherms parallel with the isohalines in the south and east of the North Sea, but cutting them nearly at right angles in the more open waters of the north and west. The difference in the broad action of the Atlantic in the wide part of the sea and the river-like action of the Channel in the southern part is brought out in a most interesting manner.

It is very important to secure a great extension of surface observations, and this, we believe, is now being done by many shipmasters who make regular observations on the various trade routes across the North Sea. Even if these fall short of the high accuracy attained by the special scientific vessels, they will prove invaluable in fixing the general run of the isotherms during the quarterly cruises, and of following the changes which take place between them.

We consider that these bulletins are satisfactory and full of the promise of large results. The too scanty letterpress is printed in parallel columns in German and English; the title only is in French.

ARCTIC GEOLOGY.

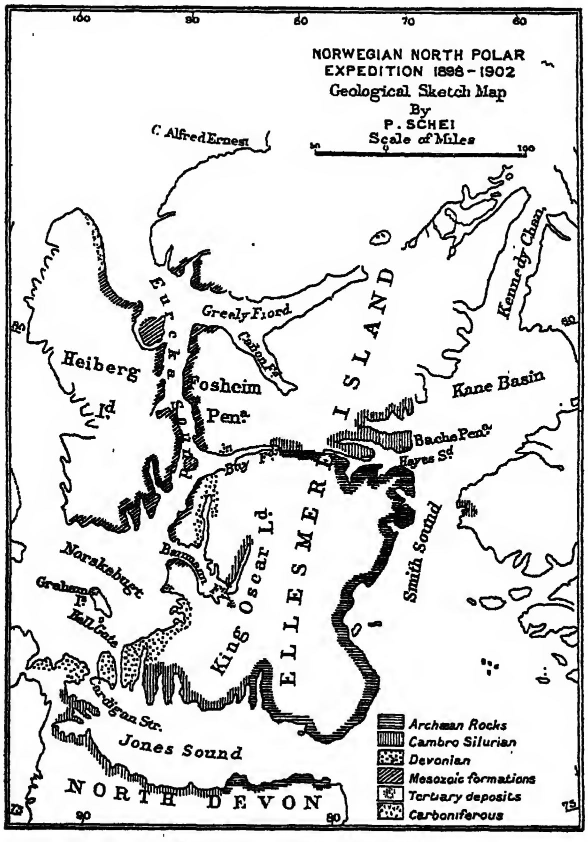
DR. P. SCHEI'S preliminary sketch of the geological work accomplished during Captain Sverdrup's four years' exploration of the region west of Smith Sound, an account of which is given in the *Geographical Journal* for July, makes important additions to our knowledge of Arctic geology.

About a quarter of a century ago Sir G. Nares's expedition examined the northern and eastern coasts of Grinnell Land down to the north-east corner of Ellesmere Island. The collections brought back by the *Fram* continue the geological information from this district round the southern part of that land mass, now named King Oscar Land, and all up its western shore to the north of Greely Fjord, including also the eastern coast of a newly-discovered island called Heiberg Land, and the coast of North Devon, south of Jones Sound, thus filling in the angle between Smith Sound and the group of the Parry Islands. Possibly they complete our general knowledge of this region, for Captain Sverdrup is disposed to think no more land exists to the north and north-west of Heiberg Land.

Previous explorations, summarised by Messrs. Feilden, De Rance and Etheridge in the *Quarterly Journal* of the Geological Society for 1878, proved the existence of crystalline Archæan rocks in the north-east of Ellesmere Island, of ancient sedimentaries, possibly Huronian, along the western coast of Kennedy Channel as far as the north-east angle of Grinnell Land, where they were succeeded by Carboniferous strata (with a little Devonian). West of these were Archæan schists, and those in the south were parted from the Huronians by a tract of Upper and Lower Silurian. Tertiary deposits, presumably of Miocene age, were discovered at more than one spot on both sides of Smith Sound and the channel north of it, and ample proofs obtained of a comparatively recent general elevation of the land, in some cases amounting to a thousand feet. Dr. Schei confirms the existence of the older Palæozoics near the middle of Ellesmere Island. Archæans follow them to the south, and continue along the coasts of Smith and Jones Sounds, appearing also on that of North Devon. On both sides they are succeeded by Cambro-Silurian deposits, and these, just at the western end of Jones Sound, by Devonian, which occur on both sides of the strait and extend some distance up the west coast of King Oscar Land. That formation had been already identified in the Parry Islands, and is now proved to extend over a considerable area. The strait parting Ellesmere Land from Heiberg Land is bordered by Mesozoic strata, which had already been detected in the Parry Islands, and these in the most northern part of

Heiberg Land are underlain by Carboniferous, with some interesting volcanic deposits. Tertiary strata were detected on Baumann Fjord, west of King Oscar Land, containing plant remains in an unusual state of preservation. Towards the western side glaciers are neither frequent nor large, owing probably to a deficient precipitation, and no signs were found of their having had a greater extension.

Thus Dr. Schei's researches corroborate and carry further the work of his predecessors. They show that a plateau-like region of Archæan rocks was submerged—perhaps before the beginning of the Palæozoic—and was buried beneath Cambrian, Ordovician, and Silurian deposits, it may be in orderly succession. These were followed by Devonian and Carboniferous, both marine, and possibly without interruption. After a break, with considerable physical disturbances, some beds of Triassic age were deposited, which are succeeded by Jurassic. Another great break is only



(From the *Geographical Journal.*)

interrupted by isolated Tertiary deposits, and, with the exception of a considerable late or post-Glacial submergence, terrestrial conditions may have been since then generally persistent.

T. G. BONNEY.

FISHERIES INVESTIGATION IN IRELAND.

IRELAND seems to be happier for the moment than either England or Scotland in the organisation and in the results of its official fisheries research. In England the official Fisheries Department has been for some years under the Board of Trade, and is soon, we believe, to be transferred to the Board of Agriculture. It has had no laboratories, no boats, and no scientific assistants, and it is no reflection upon H.M. Inspectors of Fisheries in such circumstances to say that they have carried on no biological, chemical, or other laboratory investigations.

In Scotland there is the well-known Fishery Board, provided with laboratories, vessels, and a sea-fish hatchery, and much good scientific work has been done in the past by Dr. Fulton and his able staff; but it is said that nearly all the available funds (without which practical work cannot be carried on), and the energies of the scientific men, of the Fishery Board for Scotland have now been diverted for several years into the service of the international North Sea investigation scheme.

In Ireland matters seem to be managed better. Competent scientific men are carrying on important investigations having for the most part a direct bearing on the local fisheries, and there seem to be sufficient funds not only to meet the necessary expenses of the work, but also to publish the results in suitable form—with coloured plates and other good illustrations. Across the Irish Sea there is a "fisheries branch" in the Department of Agriculture and Technical Instruction, and the two names that appear prominently in connection with the work—Wm. Spotswood Green and E. W. L. Holt—are ones that command respect from marine biologists and from fisheries experts alike. Mr. Green is Chief Inspector of Fisheries, and Mr. Holt is his scientific adviser, and from what we know of the work accomplished the combination seems a good one. The department in question has now issued the "Report on the Sea and Inland Fisheries of Ireland for 1901," in which, for the first time, as the report of the scientific adviser states, a part ii. on scientific investigations appears as a separate volume. It contains a couple of hundred pages and more than twenty plates, and Mr. Holt—for it is evidently very largely his work—and the department, and all others concerned, are to be congratulated on its appearance. The volume is entitled the report for 1901, but we notice occasional references to work done in 1902, and it contains the translation of a Norwegian paper said to be published in 1902. There is no harm in this, but we may be allowed to hope that the volumes for 1902 and 1903 will follow soon.

After a brief report from the scientific adviser to the chief inspector dealing with sea fisheries, inland fisheries, and the Cork Exhibition (1902), there follows an appendix, which is the main part of the book and contains a number of memoirs by Mr. Holt and his colleagues which are of both scientific and economic value. Amongst these we may note a brief account of a fishing survey of the Porcupine Bank, which is supplemented by a paper on the rock specimens trawled from the floor of the Atlantic and examined by Prof. Grenville Cole and Mr. T. Crook; a paper on Copepoda and one on Nudibranchiata by Mr. G. P. Farran; a useful paper on the British and Irish gobies, by Mr. Holt and Mr. Byrne, which is illustrated by two beautiful coloured plates and a number of figures in the text; an account of an investigation of the oyster beds of Wicklow and Wexford; and a translation of A. Wollebaek's three papers on oyster culture from "Norsk Fiskeritidende." The section on inland fisheries has papers and reports on salmon, pollen, and trout.

It is interesting to notice that Mr. Holt speaks of his oyster investigation as "part of the systematic examination of all our eastern fishing grounds, which is an item in the work of the scientific section of the fisheries branch." That is a programme such as we should expect from Mr. W. S. Green, and we have no doubt it will be ably carried out by Mr. Holt.

W. A. H.

THE SANITARY EXAMINATION OF WATER SUPPLIES.

AN extremely valuable and interesting report[1] has been issued by the sanitary authorities of the City of Chicago on the results of the chemical and bacteriological examinations of the waters between Lake Michigan at Chicago and the Mississippi River at St. Louis for the purpose of determining their condition and quality before and after the opening of the Sanitary Canal. For the diversion from Lake Michigan of the sewage of Chicago and its inoffensive disposal towards the Mexican Gulf, a canal was cut to carry the sewage, much diluted with lake water, into the Illinois River, a distance of 29 miles. From this point the Illinois River, after a course of 289 miles, discharges into the Mississippi at Grafton, which is about 38 miles above St. Louis. The investigations originated from the fact that the State of Missouri and the City of St. Louis had applied for a Federal injunction against the further operation and development of the Sanitary Canal of the Chicago Sanitary District on the ground that the purity of the water supply of St. Louis was endangered thereby. Chicago replied by instituting a commission to examine into the condition of the waters between Chicago and St. Louis, a distance of 356 miles.

The Chicago Municipal Laboratory (Dr. Gehrmann), the University of Chicago (Prof. Jordan), and the University of Illinois (Profs. Palmer and Burrill) collaborated in the work, a common plan of operation was devised, a uniform scheme for the bacteriological and chemical examinations agreed upon, and forty stations were fixed for taking the samples, of which forty were collected weekly and delivered to *each* of the three laboratories. The work extended over a period of about thirteen months, and during that time some 8600 samples were examined. The investigations show that considerable self-purification has taken place before the Sanitary Canal discharges its sewage into the Illinois (29 miles), and that this continues until, before Averyville (159 miles) is reached, all trace of sewage pollution has disappeared from the waters of the Illinois. Since there is still another 188 miles to be traversed before any pollution could reach St. Louis, the possibility of Chicago's sewage endangering the purity of St. Louis's water must be dismissed as impossible. In all probability such an exhaustive series of observations over so extended a stretch of water for so long a period has never before been attempted, and the results obtained are of considerable general interest. A valuable feature of the report is the detailed description of the methods employed for both the chemical and bacteriological portions of the examinations. The report illustrates the proper manner in which a great question, such as it deals with, should be approached and a solution be sought for, and we commend its perusal to hygienic authorities in this country.

R. T. HEWLETT.

NOTES.

THE British Rainfall Organisation, founded in 1860 by the late Mr. G. J. Symons, F.R.S., will henceforth be carried on under the sole charge of Dr. H. R. Mill, Mr. Sowerby Wallis having been compelled by ill-health to retire after more than thirty years' connection with the association.

THE summer meeting of the Iron and Steel Institute was opened on Tuesday last at Barrow-in-Furness under the chairmanship of Mr. Andrew Carnegie, the president of the institute.

THE whaler *Terra Nova*, which has been acquired by the Government and fitted out as a relief ship for the *Discovery*, left Portland on Wednesday of last week for Hobart, Tasmania, where, as has been mentioned in a former issue, she will be joined by the *Morning*. In order that she may reach her destination as rapidly as possible, she will be towed as far as Aden by one of His Majesty's ships; from Aden she will have to depend on her own resources of steam and sail. It is, however, anticipated that the two ships, the *Morning* and *Terra Nova*, will be able to leave Hobart in order to make their way south through the Antarctic ice in search of the *Discovery* by December 1.

ACCORDING to a Reuter telegram from Brest, the steamer *Français*, with the members of the Charcot expedition, which is proceeding towards the South Pole in search of Dr. Otto Nordenskjöld, left that place on Sunday afternoon last.

THE German South Polar Expedition has arrived safely at St. Helena.

A TELEGRAM from Naples on August 26 through Reuter's Agency stated that on that day a crater of Vesuvius which had been quiet since 1895 opened, and a great flood of lava poured forth.

A TELEGRAM from Wellington, New Zealand, states that an eruption of the Waimangu geyser took place on Saturday last, causing the loss of four lives.

ACCORDING to a telegram from New York a gold seeker has just arrived at Vancouver after an absence of four years, during which time he has been exploring the Mackenzie River district in the direction of the Arctic circle, and has brought with him what purports to be a piece of silk which formed part of the balloon of the ill-fated André.

WE regret to have to announce the death at Marstrand, Sweden, at the age of sixty years, of Prof. W. H. Corfield, sanitary adviser to H.M. Office of Works, and author of numerous works relating to hygiene.

A MONUMENT to the French chemist Laurent was recently unveiled by the French Minister of Agriculture at Langres (Haute-Marne).

THE *British Medical Journal* states that Dr. Stiles, who, it is said, has discovered a parasite which he believes to be effective in destroying mosquitoes, is about to put the efficacy of the destroyer to the test at Cape May or some other place in New Jersey where mosquitoes are prevalent. The investigation is undertaken at the request of Prof. Smith, State Entomologist of New Jersey, who has helped Dr. Stiles in his search for a parasite suitable for the purpose.

A REUTER telegram from Lagos states that the Legislative Council has passed a law making it a penal offence to introduce wireless telegraphy into the colony without the sanction of the Governor in Council.

ACCORDING to a telegram received through Laffan's Agency, Mr. Marconi, on his arrival at New York by the *Lucania*, stated that the vessel was never out of communication with either Great Britain or America on any day during the voyage. On Tuesday night of last week a message was received from Poldhu, when the *Lucania* was in mid-ocean, giving the result of that day's yacht race. The Nantucket station gave the result of Thursday's race. Mr.

[1] "Report of Streams Examination." Made under the Direction of Arthur R. Reynolds, M.D., Commissioner of Health, City of Chicago. December, 1902.

Marconi added that he was going to consult Mr. Edison on four inventions he has recently made for improving his system, one being a method of reducing by one-half the high power now necessary for transmitting messages.

THE inaugural address of the new session of the School of Pharmacy, in connection with the Pharmaceutical Society, will be delivered on October 1 by Dr. J. W. Swan, F.R.S., and the bust of the late Mr. W. Martindale will be unveiled on the same date, and the Hanbury gold medal presented to M. Eugène Collin for his researches in the natural history of drugs.

THE Swiss Alpenklub will, according to the *Athenaeum,* hold its *Klubfest* at Pontresina on September 12, 13, and 14. The Morteratsch glacier has been chosen for the excursions.

A GENERAL meeting of mining engineers is announced to take place in Vienna from September 21 to 26, at which many papers of interest will be read and discussed. Simultaneously, there will be held a meeting of the Boring and Mining and Metallurgical Engineers for Styria and district.

THE British Mycological Society will hold its seventh annual week's fungus foray at Marlborough from October 5 to 10. On the evening of Wednesday, October 7, Miss A. Lorrain Smith will read a note on *Gloeosporium Tiliae,* a disease of lime leaves, and Mr. Carleton Rea, the hon. sec. of the Society, will read a note on the occurrence of a Phalloid new to Britain. On the following evening the Rev. W. L. W. Eyre will deliver his presidential address, entitled "Mycology as an Instrument of Recreation."

THE fine chemical laboratory of the University of Modena, Italy, was recently completely destroyed by fire, and the library of scientific works in connection with it, comprising 60,000 volumes, also perished.

AN exhibition of electric automobile chairs is to take place in connection with the World's Fair at St. Louis next year. The chairs, according to the *Electrical World,* of New York, will have a uniform speed of three miles per hour, the operator having no control over the speed, and the same rate is maintained uphill, downhill, or on the level. The chair takes the form of a low phaeton without a cover. There are two large rear wheels and two small ones under the foot-rest. All are pneumatic-tyred; the seat is upholstered in cane. Behind the seat is a box which contains the batteries to operate the machine. If two persons desire to occupy the chair, and the service of a guide is wanted, the latter can sit on an adjustable seat at the rear. On the inside of the chair, attached to the arm, is a lever which puts the chair in motion or stops it at the will of the rider. A long lever attached to the front truck has its handle directly in the centre of the chair within easy reach of the driver. A gentle pressure guides the machine in the desired direction. A feature of the machine is a "sensitive rail" which surrounds the chair on all sides save at the rear. This prevents any accidents, for when the rail comes in contact with any object, even though it weighs but 1 lb., it presses against a device that locks the wheels and brings the chair to a dead stop.

WE learn from the *Scientific American* that Prof. Langley's 12-foot aërodrome was tested on August 8. The model flew a distance of 600 yards and then sank in 22 feet of water. When it was finally recovered, all that was left was a tangled wreck of twisted wires. The time consumed in flight was not more than 45 seconds. The course described was a semicircle. According to accounts which have been published, the motor of the machine and the rudders failed to work properly. The altitude of the machine at the time of the fall was not greater than 50 feet. The airship is stated to have been driven by an 8 horse-power hydrocarbon engine connected up with two two-bladed propellers located one on each side of the machine at about its middle point. One four-bladed wind vane rudder was mounted behind the engine; then came the rudder proper. On each side the airship was supported by a pair of white silk wings, 4½ feet long by 2 feet in width. The propellers were located on the side between the wings and turned toward each other. The wings, rudders, engine and other running gear were fastened to a central cylindrical tube of aluminium 18 inches in length and about 4 inches in diameter, and tapering at both ends. The test of the small model will, it is said, be followed at an early date by a trial by the 60-foot aërodrome which is owned by the Government, the cost of which was 70,000 dollars.

WITH reference to the letter which appeared in our issue of August 6 from Prof. C. V. Boys concerning "The American Tariff and the St. Louis Exhibition," Mr. George C. Comstock, director of the Washburn Observatory, Madison, Wis., U.S.A., writes to say that the following letter received by him from the office of the secretary of the Treasury Department, Washington, illustrates the manner in which, in one class of cases, the American customs authorities have apparently overruled the plain intent of the statute cited by our correspondent. "The Department is in receipt of your letter of the 12th inst. in which you inquire whether photographic lenses imported for colleges and universities can be admitted to entry free of duty as scientific apparatus. Paragraph 638 of the Act of July 24, 1897, provides for the free entry of scientific apparatus, &c., when imported for educational institutions and the Department, and the Board of U.S. General Appraisers, have held that photographic apparatus, dry plates, lantern slides and lenses are not scientific apparatus within the meaning of said paragraph of law, and such articles, therefore, when imported for the use of educational institutions would be liable to duty." Whether the above represents a policy of the Treasury Department in cases other than those named it is impossible to say, but it may serve to illustrate the danger of relying upon a lay interpretation of the Tariff Act, and the need for determining in each particular case the policy pursued in the custom house. The possibilities of interpretation presented by a Board of Appraisers that holds photographic lenses not to be scientific apparatus seem unlimited.

A FEATURE of the mosquito as the agent of malaria that has in the past been difficult to understand is that occasionally a locality is found where the physical conditions appear to be such as to favour the development of malaria, susceptible species of anopheles abound, and yet malaria is absent. Not only do such areas exist in some cases in immediate proximity to active foci of the disease, but the introduction of persons whose blood contains the malarial parasite is unattended by the development of malaria in others. The mosquitoes of such immune areas appear, in fact, to be insusceptible, but the cause has been hitherto unknown. The researches of Dr. Schoo, however, to which Lieut.-Colonel Giles directs attention in the April number of the *Indian Medical Gazette*, offer an explanation. Dr. Schoo observed that, so long as they were fed on acid fruits, it was extremely difficult to infect mosquitoes with the malarial parasite, while they were easily infected when the acid food was withheld. This observation accords with a

point noticed by Prof. Celli, who has stated that one of the Italian immune areas is remarkable for an enormous development of the cultivation of the tomato, a fruit rich in vegetable acid, and an attractive food for mosquitoes. The necessity of further investigation of this matter is clear, for if confirmation is obtained, such knowledge may be of much importance in its practical application for the prevention of malaria.

THE micro-balance exhibited by Prof. Nernst at the Berlin congress is described in a recent number of the *Berichte*, and a number of results are given which illustrate its remarkable sensitiveness and accuracy. The control is a stretched quartz fibre, and the pointer moves over forty small divisions, each of which represents 0·03763mg., and can be read to a twentieth part. The scale pan is a tiny platinum tray weighing only 20mg., and in this the analyses are carried out. Three analyses of calcite, in each of which less than 3mg. was taken, gave $CO_2=43{\cdot}80$, 43·66, and 43·81 per cent., theory 43·96, and the ignition of a single milligram of yttrium sulphate gave the atomic weight as 88·0 and 87·8, theory 89. The balance is specially suited for the analysis of traces of rare earths, and an attempt was made to carry out a fractional distillation of the chlorides of yttrium, erbium, and ytterbium in a platinum tube, but analysis showed that the sublimate had the same composition as the residue. Even where considerable quantities of material are available, as in the analysis of the salts of organic acids, the use of the micro-balance would lead to a great reduction of time and trouble, as it would only be necessary to read the deflection before and after igniting a trace of the salt. The balance, in a portable form, is manufactured by Messrs. Spindler and Hoyer, at Göttingen, and is sold at 70 marks.

OWING to the growing use of fused quartz in physical and chemical experiments, considerable interest attaches to determinations of the coefficient of thermal expansion of this substance. Several papers on this subject are before us. Messrs. L. Holborn and F. Hemming, in the *Annalen der Physik* (4) x., find an average value for the coefficient of expansion between 0° and 1000° of $5{\cdot}4\times10^{-7}$, but consider that the relation between length and temperature cannot be adequately expressed even by a quadratic formula within these limits. Mr. Karl Sheel, using optical interference-methods, and working with the temperatures 15°, 56° and 100°, obtains between these temperatures the formula

$$l_t=l_0(1+0{\cdot}322.10^{-6}t+0{\cdot}00147.10^{-6}t^2),$$

while for expansion of crystalline quartz parallel to its principal axis he finds

$$l_t=l_0(1+7{\cdot}144.10^{-6}t+0{\cdot}00815.10^{-6}t^2).$$

In the *Bulletin des Séances* of the French Physical Society, M. A. Dufour, in treating generally of the uses and properties of fused quartz, refers to the work of Holborn and Hemming, Le Chatelier and Callendar, and points out the difficulty of forming junctions between the quartz and metal or glass, consequent on the low coefficient of dilatation of the former. Mr. Sheel finds confirmation of his results in a recent paper by Chappuis, who also used optical methods in his determinations.

IN the July issue of the *Quarterly Journal of Microscopical Science*, Dr. R. Evans, of the Georgetown Museum, describes a new species of Peripatus from British Guinea, illustrated with a coloured plate. The species is said to be markedly different from the other members of the group from the same district. The author remarks that measurements and descriptions of colours and markings from preserved specimens are of little value in specific discrimination, and are, indeed, liable rather to cause confusion. In the same journal Dr. G. C. Bourne describes and figures a new ascidian (*Oligotrema psammites*), belonging to the family Molgulidæ, dredged off New Britain. The peculiarities of the new form are twofold. Firstly, it differs in general appearance and structure from the other members of the group, presenting a superficial resemblance to a sea-anemone. Secondly, as indicated by the occurrence of small crustaceans in its interior, it has a different class of nutriment. It is, in fact, "an ascidian which captures and feeds on active crustacea of large size relatively to itself, and is no longer dependent on minute organisms and organic débris swept into its branchial chamber by ciliary currents."

"THE BUILDING OF THE GRAMPIANS" is perhaps about as difficult a geological subject as could be found, but thanks to the labours of James Nicol, Sir A. Geikie, Prof. Lapworth, and others, much has been done, while the memoirs and maps of the Geological Survey form a good basis for further work and criticism. Mr. Peter Macnair has dealt boldly and confidently with the subject (Royal Phil. Soc., Glasgow), his object being to bring out the striking similarity which exists between the structure of the Grampians on the one hand and the Alps on the other, the Grampians being regarded as simply the basal wreck of such a mountain chain as the Alps. He is more confident than others are of the succession of the rock-groups met with in the Highland schists, but when he comes to criticise the belt of supposed Arenig rocks along the southern Highland frontier, he finds that there no reliance can be placed upon the apparent order of succession. He may be right in maintaining that there is nothing to justify the separation of this supposed Arenig belt from the crystalline schists. He may be right also in his criticisms on the structure of the Cowal region, with especial reference to the development of the foliation planes. This much may be said, that while hammering earnestly at the rocks, he has also made a careful study of the work of others, and he attacks the Highland problems with evident enthusiasm for his subject. We must leave to those concerned the defence of the positions which he assails, although in some instances Mr. Macnair has advanced, perhaps, where others fear to tread.

PROF. JOLY has done well to undertake the petrological examination of paving sets. In the first part of his work (*Sci. Proc.* Royal Dublin Soc., vol. x., No. 5) he deals more particularly with certain granites, diorites, and dolerites. In his general remarks he observes that the resistance to wear varies directly, as do the amounts of quartz and felspar, the holocrystalline igneous rocks being as a rule the toughest. Markedly porphyritic, vesicular, and glassy rocks are to be avoided. He deals with the durability and with the character of the surface produced by various paving sets, remarking that mechanical forces are applied on the roads in the most destructive form, the attrition and crushing being combined with the solvent action of impure waters. Fine-grained rocks, such as the diorite of Penmaenmawr, may become too slippery for use on inclined surfaces; a certain coarseness of grain is usually desirable.

WE have received the annual report (vol. xii.) of the Geological Survey of Canada for 1899 (dated 1902), by Dr. Robert Bell, acting director. This is a bulky work made up of various independent reports lettered A to S, and

separately paged. Reference has already been made in NATURE to the more important matters dealt with. A general index is appended, which gives the paging under the reference letter of each report. The volume is accompanied by maps of the Klondike Gold-fields, and of parts of British Columbia, Ontario, Quebec, and New Brunswick.

AN orographic sketch of Korea, with photographic illustrations and an excellent map, has been published by Dr. B. Kotô (*Journ.* Coll. Science, Tokyo, Japan, vol. xix.). He discusses the various faults and folds which have influenced the scenery of the peninsula—a region which, as he remarks, in reference to Suess and Richthofen, "seems to have interested our two masters almost as deeply as it has the political leaders of our times." The Cretaceous Cephalopoda from the Hokkaidō are under description by Mr. H. Yabe. Part i., dealing with Lytoceras, Gaudryoceras, and Tetragonites, is accompanied by seven plates (*Journ.* Coll. Science, Tokyo, vol. xviii.).

MR. F. CHAPMAN AND MR. H. J. GRAYSON contribute an article on "Red Rain" to the *Victorian Naturalist* (vol. xx., June). After discussing the subject generally, they direct attention to falls of red mud in Victoria in February and March of this year. In one case the amount was estimated to equal fifty tons per square mile. The material comprised much limonite, and many mineral fragments and diatoms. The material was probably derived from areas from 30 to 300 miles north and west of Melbourne, being swept up from the borders of swamps and salt lakes during an abnormal season of drought.

IN a monograph supplement to the *Psychological Review* (vol. v. No. 4), Mr. J. B. Miner reports a study of "Motor, Visual, and Applied Rhythms." It has been frequently asserted that rhythmical grouping of sensory impressions is peculiar to auditory and tactual perception, but Mr. Miner shows that a series of similar visual impressions regularly repeated may fall into spontaneous rhythm, and that, in fact, visual impressions obey laws of rhythm very similar to those established for auditory perception. Since rhythm is, as Mr. Miner rightly maintains, a feature of the motor expression evoked by sensory impressions to which the attention is directed, there is no reason to suppose that it should be limited to perception by any one or two of the senses, and it may be hoped that the erroneous statement to that effect will now disappear from the text-books. Mr. Miner shows that subjects seem to fall naturally into two classes, according as their power of concentrated mental work is favoured or hindered by a concurrent rhythmical stimulus to the senses; that those who naturally work most rapidly and concentratedly are most apt to be hindered; while those who work slowly, with less tense concentration, in many cases produce better results under the influence of such stimulus. This unexpected result suggests to the author certain pedagogical reflections.

THE *Barbados Agricultural Reporter* of August 1 contains the text of a petition to the Governor praying that the destruction of mongooses may be authorised in the island. A quarter of a century ago the sugar industry of the island suffered much from the depredations of rats, and about 1878 mongooses were introduced for the purpose of thinning their numbers. These carnivores discharged their task with conspicuous success, but at the same time they cleared off much of the indigenous fauna. The destruction of the lizards has led to a large increase in the number of moth-borer caterpillars, which perforate the sugar-canes and thus give entrance to the spores of noxious funguses. These cause a serious loss, which it is hoped may be in some degree mitigated by the destruction of the mongooses. All this shows the danger of attempting to interfere with the equilibrium of nature.

IN the annual report of the Indian Museum, Calcutta, for 1901–2, Major Alcock, the director, states that a bronze medallion portrait and inscribed brass tablet have been placed in one of the verandahs of the old museum building in memory of the late Dr. J. Anderson, the first superintendent of that institution. During the period under review the museum has acquired by purchase the valuable de Nicéville collection of Oriental butterflies, which includes a large number of type specimens.

THE *Journal* of the Straits branch of the Royal Asiatic Society contains two important communications on the language of the Sakais and Semangs of the Malay Peninsula. Mr. H. N. Ridley describes some new Malay orchids, while Mr. P. Cameron continues his account of the Hymenoptera collected by Mr. R. Shelford in Sarawak. To the *Zoologist* for August, Mr. Shelford himself contributes some highly interesting notes on the habits of Bornean species of mantises, with illustrations reproduced from photographs of these insects.

IN the journal last mentioned, the Rev. F. C. R. Jourdain records the occurrence of an example of the harp-seal (*Phoca groenlandica*) at Teignmouth on March 10, on what appears to be sufficient evidence. The carcase was seen on a fishmonger's barrow, but it is not known how it was disposed of. The species is a very rare straggler to the British shores.

THE recent additions to the Municipal Museum of Hull are made known to the public by means of illustrated notes and short articles in the *Eastern Morning News*. These are subsequently reprinted as penny pamphlets under the title of "Hull Museum Publications." By this means the local public are kept in touch with the growth of the museum, and it certainly must benefit the museum, as well as interest and instruct the public. This system might with advantage be copied by other local museums. The fifteenth publication, entitled "Quarterly Record of Additions, No. 5," has just been published.

THE report of the Trivandrum Museum for the year 1901–2 contains a reprint, with two coloured plates, of a paper from the *Journal* of the Bombay Natural History Society, on a couple of cetaceans recently stranded on the beach near that city. One of these has been identified by Mr. Lydekker with the widely spread *Pseudorca crassidens*, while the second is made the type of a new species, *Tursiops fergusoni*, named in honour of the director of the museum.

IN a third museum report just to hand, that of Manchester for the year 1902–3, special attention is directed to the acquisition of the interesting series of mammalian remains from a cave of Pliocene age at Doveholes, Derbyshire. These remains, which it will be remembered were exhibited at the soirée of the Royal Society in the spring, have recently been described by Prof. W. B. Dawkins in the Geological Society's *Quarterly Journal*.

THE *Zoological Society Bulletin*, published by the New York Zoological Society, is a brightly written, well illustrated periodical, and the July issue, which has just reached us, contains quite a number of interesting contributions, notably one on "Training Orangs and Chimpanzees," in which particulars are given of the acquired accomplishments of past and present members of the New York Zoological Park collection. The training of the orang-utan

and the chimpanzee, remarks the writer of the article, closely approaches the management of an untaught child. These creatures do not seem as much like lower animals as do the majority of the so-called "dumb brutes." Coaxing and perseverance have been responsible for the exhibitions which from time to time have taken place.

IN the *Journal of Botany* (August) Dr. G. Murray publishes a short note on Atlantic diatomaceæ. Some few species were obtained in all the captures, even far out at sea, but an increase in the quantity of the take was generally found to indicate the proximity to land. Miss A. L. Smith describes some interesting microfungi, and Dr. W. G. Smith refers *Nidularia dentata* to the genus Sphærobolus. Biographical notices of the botanists L. A. Deschamps and F. Noronha are contributed by the editor.

THE number of the *Minnesota Botanical Studies* published in July is mainly given up to articles dealing with flowerless plants. Mr. Bruce Fink presents a list of lichens collected on the northern boundary, and Mr. H. L. Lyon catalogues the pteridophyta which grow in the State. Contributions to the algal flora are furnished by Dr. H. F. Schrader, who describes a new species of Alaria, and by Mr. Skinner, who discusses the tide pool vegetation at Port Renfrew. The distribution differs considerably from that found on our coasts, seeing that a Corallina extends throughout the whole tidal range, while a Codium is associated with it in the higher pools.

THE *Agricultural News* of Barbados for August 15 reprints from the *India Rubber World* an interesting article on the subject of the preparation of Para rubber in Ceylon, in which full and detailed instructions are given for collecting and coagulating the rubber. The text is elucidated by illustrations.

A PAMPHLET on "The Boiling Lake of Dominica," by Mr. F. Sterns-Fadelle, has lately been published (office of the *Dominican*, price 1s.). It gives an historical and general account of this well-known geyser, which will be useful to travellers in the West Indies.

THE annual report of the Yorkshire Philosophical Society for 1902 contains part ix. of a catalogue of British plants in the herbarium of the Society, and a popular article on "Sea Sand," by Mr. Hugh Richardson, in which the characters and origin of the grains of sand are discussed.

IN the *Proceedings* of the Nova Scotian Institute of Science (vol. x. part iv.) Dr. H. M. Ami shows that the slates yielding *Dictyonema Websteri*, and which were regarded by Sir J. W. Dawson as Upper Silurian, belong to the Upper Cambrian.

A PAMPHLET entitled "A Historical Sketch of the Experimental Determination of the Resistance of the Air to the Motion of Projectiles," by the Rev. Francis Bashforth, has recently been published by the Cambridge University Press.

MESSRS. CHARLES GRIFFIN AND CO., LTD., have published a second edition of "Animal and Vegetable Fixed Oils, Fats, Butters, and Waxes," by the late Dr. C. R. Alder Wright. The new edition has been revised and partly rewritten by Mr. C. Ainsworth Mitchell, who, though he has retained the general arrangement of the original work, has, especially in the chapters dealing with the manufacturing processes, modified the text and brought it up to date.

A NINTH edition of Bloxam's "Chemistry" has been published by Messrs. J. and A. Churchill. The book has been rewritten and revised by Prof. J. M. Thomson, F.R.S., and Mr. A. G. Bloxam. A change has been made in the present edition in the order of treatment of the non-metallic elements, and carbon is now considered after hydrogen, oxygen, and nitrogen. The plan of making no division, in the portion of the book dealing with organic chemistry, between the treatment of the fatty and aromatic compounds has again been followed.

A NEW edition—the twelfth—of "The Art of Retouching," by Mr. J. Hubert, has just been issued by Messrs. Hazell, Watson and Viney, Ltd.

MESSRS. GEORGE ROUTLEDGE AND SONS, LTD., announce for early appearance a series of "Nature-Study Readers" for general school use, under the editorship of Mr. John C. Medd. The aim of the books is to present varied aspects under which nature may be most conveniently studied alike in urban and in rural districts. Each subject is to be treated by a different writer, who has devoted special attention to it, and knows from personal experience what is within the capacity of, and calculated to interest, children of from nine to thirteen years of age.

MR. R. LYDEKKER, F.R.S., will shortly issue, through Messrs. Hutchinson and Co., a volume of zoological essays entitled "Mostly Mammals."

THE additions to the Zoological Society's Gardens during the past week include a Himalayan Bear (*Ursus tibetanus*) from East Asia, presented by Lady Constance Mackenzie; a Common Otter (*Lutra vulgaris*) from Scotland, presented by Mr. J. B. A'Deane; a Rock Thrush (*Monticola saxatilis*), European, presented by Mr. W. H. St. Quintin; a Delalande's Gecko (*Tarentola delalandii*) from West Africa, presented by Mr. P. C. Challice; a Black Lemur (*Lemur macaco*), a Black-headed Lemur (*Lemur brunneus*) from Madagascar, a Black Sternothere (*Sternothoerus niger*) from West Africa, seven Dalmatian Lizards (*Lacerta mosorensis*) from Dalmatia, twelve Sharp-headed Lizards (*Lacerta dugesi*) from Madeira, an Indian Eryx (*Eryx johni*) from India, a Black-tailed Snake (*Ungalia melanura*), a Black-spotted Snake (*Ungalia pardalis*), a Cuban Snake (*Liophis andreae*) from Cuba, deposited.

OUR ASTRONOMICAL COLUMN.

SPECTRUM OF COMET 1903 *c*.—Observations of the visual and photographic spectra of this comet were obtained at the Meudon Observatory, and were communicated to the Académie by M. Deslandres, whose communication appears in the *Comptes rendus* for August 17.

A spectrograph containing a 60° heavy flint glass prism was especially constructed for these observations, and was used in conjunction with the large double telescope. The faint light of the comet was concentrated from a wide slit by having the collimator of the spectroscope 55cm. long, whilst the focal length of the observing telescope or camera was only 12cm.

The spectrum generally is of the characteristic hydrocarbon type, but near to the nucleus of the comet it contains several extra faint lines; the brightest bands are those at λλ 3881, 4681, 4314 and 4052, their relative intensities being 10, 8, 7 and 7 respectively. The blue bands at λ 473 are separated into their several groups, thus affirming the presence of the hydrocarbon spectrum; this separation was also noticed in the spectrum of Rordame's comet (1893 *b*) obtained by Campbell at Lick in 1893, with which Deslandres's spectrum is practically identical.

M. Deslandres proceeds to note the similarities and differences of the cometary spectrum and the cyanogen spectrum as obtained in laboratory experiments, and suggests, as an explanation of the differences, that, although

the temperature of the comet is of the same order as the laboratory temperature, and high enough to produce incandescence, yet it is not sufficiently high to dissociate the compounds and thus produce the hydrogen and nitrogen spectra as obtained in the laboratory.

In the concluding portion of his communication M. Deslandres describes some experiments, similar to those by which he has obtained such excellent results in determining planetary rotations, whereby the differential movements of a comet's various parts may be determined from the inclination of its spectral lines to the lines of two comparison spectra photographed alongside the spectrum of the comet.

THE SPECTRUM OF NOVA GEMINORUM.—A telegram from Prof. Pickering, published in No. 3895 of the *Astronomische Nachrichten*, announces that the spectrum of Nova Geminorum was observed by Dr. H. D. Curtis at the Lick Observatory on August 17, and was seen to be of the nebular type which is characteristic of the spectra of declining temporary stars.

UNITED STATES NAVAL OBSERVATORY.—Vol. iii. (second series) of the United States Naval Observatory *Publications* has been received, and contains some 550 pages of useful observational details and results.

Part i. is devoted to observations of Eros made with the twenty-six inch equatorial and the Clark micrometer "No. ii," during 1900–1901, by Messrs. T. J. J. See and G. K. Lawton. After a description of the instrument, which has recently been supplied with an entirely new mounting by Messrs. Warner and Swasey, Dr. See proceeds to give details of the instrumental constants and their determination, and then gives the results of the individual observations for each night.

Assistant-astronomer King has used the nine-inch transit circle for observations of Eros and the reference stars suggested by the Conférence Astrographique Internationale of July, 1900, and, in part ii. of the report, gives the individual results of his observations.

Part iii. is a detailed description of the observations of 495 zodiacal stars made with the nine-inch transit circle by Prof. Eichelberger in accordance with Sir David Gill's catalogue of 2798 zodiacal stars which it was intended to observe, but in November, 1900, it was found that the pivots of the instrument were badly worn, and therefore the work is suspended until the necessary repairs have been effected.

In part iv. Mr. Updegraff gives a description, a photograph, and a diagrammatic sketch of the six-inch steel transit circle, and in a lengthy introduction gives minute details of the determination and reduction of the instrumental constants, followed by the separate observations of 130 comparison stars for the planets, including a large number of observations of reference stars for Eros. This section is concluded by two catalogues of stars and their positions, the first containing 139 zodiacal stars, and the second the Eros reference stars.

Part v. concludes this publication, and contains the individual observations made with the prime-vertical transit instrument from 1882 to 1884 by Lieutenants Ingersoll and Bowman and Ensign Taylor, all of the U.S.A. Navy.

THE WHITE SPOTS ON SATURN.—In the *Astronomische Nachrichten*, No. 3894, Senor J. Comas Solá, of Barcelona, publishes his observations of Barnard's white spot and the smaller white spots which have been recently observed on Saturn.

Using a six-inch equatorial, he easily observed Barnard's spot and several smaller ones. On June 26 the former crossed the central meridian at 13h. 19m. (G.M.T.), and was seen to be double, whilst in contact with it, and on the left side (reversed image) a small spot was observed. On July 1d. 13h. 55m.± a feebler spot, which also appeared double, was observed to cross the central meridian in the same zone as the larger one. By July 20, when it crossed the meridian at 11h. 32m., the large spot was seen to be much feebler and apparently elongated, and on July 28 (time of transit =11h. 15m.) it was yet feebler, and a rather difficult object for the six-inch.

Several other spots were observed, and their times of transit recorded, by Senor Solá, and, as a first approximation, he finds the rotation period of the planet to be 10h. 38·4m.

THE TEACHING OF PSYCHOLOGY IN UNIVERSITIES OF THE UNITED STATES.[1]

A TRUE estimate of the position of psychology in the curriculum of American universities can hardly be formed without a brief survey of the general system of education which prevails there. In earlier years, one need hardly say, the training was far narrower and less liberal than it is now. The candidate for the B.A. degree had his educational career as carefully prescribed for him as if he were still at school, and he had little or no opportunity to deviate from it. At the present day, the various universities of the United States offer every gradation between relatively elective and relatively non-elective systems of study. In most universities the undergraduate will find his course of work strictly defined during at least his first or freshman year. Little by little, however, the elective is gradually replacing the non-elective system. Quite recently, Harvard, for example, determined to allow a very considerable measure of optional subjects, from which the student has to make his choice from the moment he is admitted to the university.

The danger of such a system is increased by the absence of any special *ad hoc* examination for the B.A. degree. As a rule, this degree is conferred solely on the results of the terminal examinations held biannually, so that, unless proper precautions were taken, it would be possible for a student, after having passed his three or four years at college, to graduate on the basis of a superficial and very elementary knowledge of many subjects, and a detailed knowledge of none. This drawback American universities have largely succeeded in overcoming by a series of appropriate regulations concerning the relative number of elementary and advanced lectures at which attendance is required, and concerning the conditions of admission to advanced lectures. At Yale, for example, undergraduate studies are ranged under three heads:—(1) Languages and literature; (2) mathematics, physical and natural science; (3) philosophy, history and the social sciences. Every student is required to have attended advanced courses in at least one of these departments, and to show at least an elementary knowledge of subjects in the two other departments.

It will now be evident why subjects which in English universities are studied by the few are in America taken up by the many. Take Yale, for instance, with her department of philosophy, history and the social sciences. Every undergraduate has to show at least an elementary knowledge of some subject in this department, *i.e.* of philosophy, psychology, ethics, pedagogics, logic, ancient, mediæval and modern history, economics, politics or sociology. Large numbers of American students take a course of economics. At one university I was told that, on an average, every student takes two courses of economics during his undergraduate career. This fact may be ranged beside another, viz. that there are twenty-four professors, lecturers and instructors of political economy at Harvard.

So also it comes about that a great number of students take up psychology, either by itself or with allied subjects. 250 students, chiefly in their second or sophomore year, attend the year's course at Harvard, which is equally divided between the study of logic and the study of elementary psychology. At Yale a similar year's course on ethics and psychology was attended this year by 225 students. At Cornell the year's course on psychology, logic and ethics is attended by 200 students. Princeton goes so far as to make psychology a compulsory subject, without which the B.A. degree cannot be obtained. The popularity of psychology is also shown in that it is taught in the upper forms of some of the better schools.

Experimental work in the laboratory is only performed by students who intend to proceed further in psychology. Their number is a very small fraction—from one-tenth to one-fifteenth—of those who attend the preliminary course. At Columbia they are expected to have attended either a general course on experimental psychology or a special course, in which no less than eight lecturers take part, each being responsible for a few lectures in his own department of psychology, be it physiological, genetic, comparative,

[1] Paper read before the Psychological Society at Cambridge, July 25, by Dr. C. S. Myers

pathological, experimental, historical or philosophical. By this means the student comes into relation with most of the teaching staff of the department in which he is interested. Later, more advanced courses are open to him in analytical psychology, educational psychology, the philosophy of mind, genetic psychology, and so on. At Pennsylvania the student spends two years at psychology, devoting the first half-year to analytical psychology, the second half-year to physiological psychology, the third half-year to synthetic psychology, and the fourth half-year to experimental psychology. Each of these half-courses comprises lectures and practical work, of an hour and two hours' duration respectively per week.

It would be wearisome to follow out at further length the various lines of undergraduate study pursued in psychology at the several universities visited by me. You will, however, hear with interest that men are offered at Yale a course of recent German psychology in their fourth or senior year, the class reading extracts from the works of Brentano, Wundt, Stumpf, Külpe, and others, while the different attitudes of these psychologists are explained by the instructor. At Harvard a half-year's course on the mental life of animals is offered, accompanied by lectures and demonstrations. At Cornell a course on the history of the psychophysical work of Weber, Fechner, and others is given.

This brings me to the more detailed consideration of experimental work in the United States. The laboratory in Harvard University has eleven rooms, in Yale it has seven, in Columbia nineteen, in Princeton five, in Cornell ten, and in Clark ten; these numbers generally include all public and private rooms of the department. Cornell has undoubtedly the best equipped laboratory, so far as human psychology is concerned. Two rooms here are devoted to vision, one to acoustics, one to touch, one to taste and smell, one to chronometric apparatus, one is a special research room, and there is a lecture room and a workshop. Both Clark and Harvard have rooms devoted to experiments on animals. Partly for this reason the Harvard laboratory suffers from lack of space; a new one will be built in the near future. Most laboratories have a departmental library, or at least a seminary, in which the students can read or meet for discussion. Practically all the laboratories have a workshop, and employ a trained mechanician, who is able to turn out even complicated and expensive apparatus.

The methods of conducting the experimental work naturally differ in the various laboratories. At Harvard and Columbia lectures are given in connection with the experiments, but at many other universities lectures and practical work are wholly independent. At Yale, Harvard, Princeton and Cornell, students work together in pairs, each member of a pair serving alternately as subject and as experimenter. At Pennsylvania students work together in groups of three, the third recording the results obtained by the two others. Stress is laid in most laboratories on the careful keeping of note-books. Many of those in Cornell are models of neatness and diligence; there they are inspected, marked and initialled monthly by the assistants. At Princeton, the times are so arranged that only a single pair of students is working in the laboratory at any one hour; they thus secure the undivided attention of the instructor. At Harvard and Pennsylvania the entire class is engaged upon the same kind of experiment simultaneously; the Pennsylvania students are each provided with lockers containing the simpler apparatus they are likely to use. At Yale and Cornell, on the other hand, students are simultaneously engaged at different experiments; one pair, for instance, is working on colour-vision, another on reaction-times, another on tactile sensibility, and so on. Save at Cornell, the students are each taken through all the laboratory experiments commonly described in the text-books. But at Cornell it is held sufficient for the student to devote himself to the investigation of a single sense, working over perhaps fifteen experiments therein, and then to proceed to one or two experiments on the expression of the affective states, thence to some of the experiments in attention and reaction, and so on, whereby he acquires a practical experience, less extensive, but probably more thorough than that usually obtained. He works four and a half months in qualitative, and four and a half months in quantitative, experimental work during his third year. His fourth year is devoted to some special problem, and he writes an essay on his results.

If, having taken his B.A. degree, the graduate determines to pursue his studies further, he enters the post-graduate school in order to proceed to his doctor's degree. After two or three years' post-graduate study, he may present himself for examination in a chosen division, *e.g.* philosophy, and within the division he must name some special field of study, *e.g.* psychology, in which he is liable to minute examination and must offer a thesis, showing evidence of independent research. In psychology, as in all subjects, advanced lectures are delivered to suit his requirements. At Cornell during his first year of post-graduate study, the student does not start any special research work; he reads and roams about the laboratory, observing what his senior fellow-students are doing. A very large proportion of post-graduate students at Yale and Harvard consists of graduates from smaller universities. At Harvard I found no less than sixteen students engaged in the psychological laboratory at original work for their Ph.D. degree. They attended there at fixed times in the mornings only, working in pairs alternately as subject and as experimenter. Weekly seminary meetings are held at Harvard, Yale, and Clark for post-graduate students. At Harvard three papers are read at each evening meeting by the students, and are discussed by themselves and their professors. At the Yale seminaries, a post-graduate student presents a paper weekly, dealing with the system of some well-known mental philosopher. At Clark, the students meet each week at the professor's house to narrate and criticise their progress in research work.

A very large proportion of theses, written for the Ph.D. degree in psychology, sees light in the pages of American psychological journals. In many instances this must turn out to be the one piece of original work such men have performed in their life. They drift away in various directions. The best are chosen by their professors to be laboratory instructors for a year or more. Thence they go to become assistant professors in other universities, or depart earlier to teach educational psychology in the State normal schools or in other teachers' training colleges. Mainly through lack of leisure, the majority put forth little in the way of further and mature research. There is a strong tendency, too, for psychologists in America to turn to editorial or literary work, to become busy with the organisation of science, or to deal with purely philosophical, ethical, or religious problems.

But apart from such drawbacks, which are the result rather of American ways of life and character than of deficient interest or training, I have said enough, I hope, to show what a living subject of education psychology is in the United States. It is becoming recognised there that a man of culture should know something, not only of the works, but also of the working, of the human mind. Psychology in the United States is not a subject of the philosophical few, as it is in our country. If it pays the penalty for, it also reaps the advantage of, its position. Numbers of undergraduate students acquire a notion, however dim and imperfect, of the range and importance of psychology, so that, if ever they become successful business men, as many of them do, they are prepared to lend it financial assistance in later life. Future medical students take up psychology during their academic career, and turn their knowledge of it to account when they come to deal with the problems of insanity. Zoologists pass from their museums to study it, and return to work out the psychology of animal life. Teachers obtain a useful smattering of it, sufficient to interest and improve them in their arduous career. At Pennsylvania, for example, they have the opportunity of attending a "pedagogical clinic," at which children with various mental disorders are brought before their notice, so that they may recognise them hereafter.

From these facts it will be seen that America provides us with a lesson in the organised teaching of a subject the success of which we have so much at heart, and with an example which we should do well to follow.

AMERICAN ETHNOLOGY.

It is with melancholy interest that we receive the nineteenth annual report of the Bureau of American Ethnology, as this was the last report that was edited by the late director; Major Powell's name for so many years has been associated with the publications of the bureau which he initiated that the two have come to be irresistibly associated in our minds. We can only say that his last report fully maintains that high standard to which he has accustomed us.

Sociologists as well as ethnologists will be interested in Mr. James Mooney's historical study of the Cherokee, forming part i. of the nineteenth report. The title "Myths of the Cherokee" is misleading, as the memoir includes oral and documentary history, legendary history, legends and myths, with a valuable appendix of notes and parallels to the myths. The true history of Sequoya, the inventor of the Cherokee alphabet, is given, and the remarkable effect of this innovation on the Cherokee nation is admirably sketched, but the promise of progress was ruthlessly destroyed by the action of the Georgia Legislature. In the temperate language of a scientific historian, Mr. Mooney narrates the invariable fate of a native population when the white man wants his country, and now the five civilised tribes are meditating wholesale removal from the Indian territory where they are still being harassed. There seems a determined purpose on the part of many full-bloods to emigrate either to Mexico or South America, and there purchase new homes for themselves and families.

The second part of the report contains one or two studies of the Hopi, or Moqui, Indians of Arizona. These pueblo Indians are among the few surviving tribes of American aborigines which still retain an ancient ritual that is apparently unmodified by the Christian religion. The importance of a careful investigation of these people is fully realised by American anthropologists, and the bureau has in Dr. J. Walter Fewkes a trained observer of the first rank. It is impossible to interpret the Hopi ritual without a clear idea of the present relationship between the existing clans and of their connection with the religious societies. The growth of the ritual has increased with the successive addition of new clans to the pueblo, and its evolution cannot be comprehended without an understanding of the social development and clan organisation of the pueblo. Appreciating this, Dr. Fewkes deals with Tusayan migration traditions, and unravels the history of the accretion of the clans into a community. The localisation of these clans in various pueblos is described by Cosmos Mindeleff, and mapped in several plans; the localisation of clans was rigidly enforced in ancient times, but it is now breaking down. May we suggest to American workers in the field that valuable sociological results would be obtained if they adopted genealogical methods devised by Dr. Rivers (*Journ. Anthrop. Inst.*, xxx., 1900, p. 74). Dr. Fewkes also gives some details of the famous Snake dance; this dance was primarily a part of the ritual of the Snake clan, and ancestor worship is very prominent in it, indeed, Dr. Fewkes suggests it is "totemistic ancestor worship." There still remain to be investigated various episodes and the sacred songs. The Flute ceremony, which lasts for nine days, is one of the most complicated in the Hopi ritual. Three elements appear to be prominent in the Flute observance—sun, rain, and corn worship, symbols of which are the most prominent on the altars and their accessories. The same is true of the Snake dance; but in both rites the cultus heroes and clan mothers are special deities to which the supplications for rain and corn are addressed. This is interpreted as a form of totemism in which the ancestors of the clan take precedence. The Sun as the father of all cultus heroes, and the Earth as the mother of all gods, ancestral and otherwise, necessarily form an important part of the worship. The relation between religion and sociology is brought out by the author.

"The Wild Rice Gatherers of the Upper Lakes," by Dr. A. E. Jenks, is a sociological study of great interest and value, and should form a model for other researches on sociological economics. The Indians in the wild-rice district exhibited some social aspects that were quite unique. Their superior physique and peaceful disposition were frequently spoken of. The wild rice led to the peaceful massing together of various tribes and to love for a common country, but being a precarious food-supply, much progress in culture was impossible to these barbarians.

Other papers in the report are "Mounds in Northern Honduras," by Thomas Gann; "Mayan Calendar Systems" and "Numeral Systems of Mexico and Central America," by Cyrus Thomas. The number 20 is the base of the numeral system of the Mexican and Central American tribes, but it does not appear to have been used as a mystic number in rites. There are other peoples who use the vigesimal system, but no others are known who adopt the twenty-day month or eighteen-month year. We cannot conceive how a twenty-day period could have grown out of a lunar count; probably two time systems, a secular and a sacred one, were in use at the same time, and the latter finally obscured the former. The author's conclusion is that the priests adopted a method of counting time for their ceremonial and divinatory purposes which would fit most easily into their numeral system, and this system, in consequence of the overwhelming influence of the priesthood, caused the lunar count to drop into disuse. Prof. W. J. McGee publishes a characteristic essay on "Primitive Numbers." The memoirs in these two volumes are copiously illustrated with numerous excellent plates, some of which are coloured. A. C. H.

AGRICULTURAL NOTES.

From a recent number of a Scotch agricultural newspaper it appears that the Earl of Rosebery has a private station for agricultural research on his home farm near Edinburgh, but the gratification which this information might otherwise have afforded is tempered by a perusal of an account, given by the newspaper, of a visit paid by a party of agriculturists to the place. The experiments, we gather, have been in existence for several years, but no reports on the station's work have been published, and we are left to glean something of its character from the statements made by the estate agent and the district analyst, who respectively represent practice and science in the control of the work. In speeches which are reported at some length, first the agent and then the analyst proceeded to ridicule the work done at other experiment stations. Rothamsted, Woburn, the East of Scotland Agricultural College, and the Highland and Agricultural Society were singled out for condemnation, and one is dismayed to find that "great laughter" was evoked by a quotation of what purported to be the words of the late Sir Henry Gilbert, whose fifty years' devoted service has earned the respect of all right-minded agriculturists. The claims made for Dalmeny—the experiment station—were as amusing as the references to others were offensive. We hear, for example, that "the Dalmeny station was the only agricultural experiment station in the world where the research work was carried out on biological lines," and that "if imitation was the sincerest form of flattery, Dalmeny had been very sincerely flattered of late years, for so-called new lines of investigation were being taken up and books were being written which were simply plagiarisms of Dalmeny work and its results." Until some change is made in the management of Dalmeny experiment station it is clear that no serious consideration need be given to the work being done there.

For the past three years Mr. S. H. Collins, agricultural chemist at the Durham College of Science, has been investigating the composition of the Swedish turnip, the chief root crop of the north of England. A large number of varieties have been grown under identical conditions and also under different conditions of soil, climate, and manuring. The work is still in progress, but certain conclusions which have been come to are stated in the eleventh report of the college agricultural department. They are (1) the higher the percentage of dry matter in swedes the greater the feeding value; (2) swedes are very variable in composition, and not less than fifty roots should be sampled for the purpose of analysis; (3) the average composition of some varieties is much better than that of others; (4) the varieties which are best at one farm will also be best at

other farms; (5) next to variety, season, and then soil, most affect the composition of swedes; the influence of manuring is not marked. The fourth conclusion is warranted by the facts which Mr. Collins brings forward, but this point is one on which further information is wanted, for it seems probable that the relative position of different varieties might change if the varieties were exposed to markedly different conditions.

A *Bulletin* recently issued by the U.S. Department of Agriculture, entitled "The Mango in Porto Rico," discusses the prospects of mango cultivation on the island. Porto Rico grows mangoes in abundance; the climate is very favourable, and the trees are free from disease, but hitherto seedling trees only have been grown, and one is not surprised to read that the mangoes have met with but little favour in the American markets. The fame of the Bombay mango is due to the fruit of grafted trees, and it is rarely that trees raised from seed produce fruit worth eating. Seedling trees abound in every village, but first-rate trees are very uncommon. The short list given in Woodrow's "Gardening for India" shows how rare really good seedlings are. When the Americans import fine strains and take to growing grafted mango trees the industry is certain to make rapid progress. We gather from the *Bulletin* that this subject is likely to engage the attention of the local experiment station. We hope it may, for if the matter is taken up with the energy characteristic of the American stations, there is every prospect of a great increase in the supply of the finest of tropical fruits.

REPORT OF THE MALARIA EXPEDITION TO THE GAMBIA.

THE Liverpool School of Tropical Medicine has just issued a most important and practical report upon the prevention of malaria in the tropics.[1] Dr. Dutton, who conducted the expedition with conspicuous success, shows with striking clearness how a great deal of disease is due to the want of knowledge of the nature of malaria, and that during the dry season the residents are largely to blame for the appearance of the disease. It is one of the most hopeful reports ever issued by the school, and it shows that the governors and others in authority upon the coast are fully alive to the importance of stamping out malarial diseases. The report is an immense step forward in preventive medicine.

The object of the expedition was to investigate the conditions under which mosquitoes were propagated in the town of Bathurst and at the principal stations of the colony, and to suggest methods of destroying these insects. Malaria was found to be prevalent in the colony; 80 per cent. of the native children examined harboured malaria parasites in their blood. The liability to infection of the Europeans commences soon after the rains are established, lasting up to the end of November. The various breeding places of mosquitoes are described in detail in chapter iv. of the report, particular mention being made of the wells, canoes, boats, lighters, cutters on the foreshore, and of the grass-clogged trenches in many of the streets, which together supply Bathurst with the majority of its mosquitoes during the wet season and for part of the dry season. The number of mosquito breeding places present in compounds was found to vary with the social position of the occupier. They increased in extent and number in proportion to the wealth and position of the occupier.

An account of the examination of one of the large compounds illustrates to what extent mosquitoes are bred by the white man in the tropics on his own premises.

In one factory yard were found six barrels, and in the garden there were seventeen tubs and eight small wells, all breeding quantities of Culex, Stegomyia, and Anopheles mosquitoes. Besides these dry season breeding places, discarded domestic utensils were scattered about the yard and garden which, in the wet season, would have acted as breeding places. It is pointed out that during the dry season, from November to May, natural breeding places for mosquitoes in Bathurst cease to exist, and from this period the people breed mosquitoes solely in their own compounds.

In chapter v., which deals with the prevention of malaria in Bathurst, a campaign against the mosquito is advocated; the town is judged especially suitable for its success. Thus Bathurst is situated on a practically isolated piece of land surrounded on nearly all sides by a broad expanse of sea water. The amount of land to be dealt with is comparatively small, viz. about a square mile. The surface is fairly level, sandy, absorbing water readily. In this area the breeding places of mosquitoes are a known quantity, the artificial, or those made by man, being in excess of the natural. The rainfall is very small, and rain occurs only during four out of the twelve months of the year.

The probability of the introduction into Bathurst of yellow fever from Senegal is pointed out as another reason for attacking the mosquito. The expedition was informed by His Excellency the acting Governor, H. M. Brandford Griffith, of the intention on the part of the Colonial Government to enter upon a crusade against the mosquito, and on November 18 the preliminary removal of rubbish from houses and compounds began; a sanitary inspector was appointed, and received special instruction in the work. Under him worked a gang of labourers, and at the time of the departure of the expedition (January 10) 363 houses and compounds had been inspected. From these 131 cartloads of old tin pots and other rubbish were removed. On the return of His Excellency the Governor, Sir George C. Denton, the inspector and a sufficient staff of labourers were appointed permanently, and a grant of 200*l.* per annum was given for the special anti-mosquito work. Anti-mosquito regulations have been drawn up by the Colonial Government. These are given at the end of the report.

An appendix, by Mr. F. V. Theobald, is attached to the report; in it are described the various species of mosquitoes collected by the expedition, many of which were new to science.

[1] "Report of the Malaria Expedition to the Gambia, 1902, of the Liverpool School of Tropical Medicine and Medical Parasitology." By J. E. Dutton, M.B., and an appendix by F. V. Theobald, M.A. Pp. 46+xi. (Liverpool: University Press, 1903.)

ZONES IN THE CHALK.

IN NATURE for August 8, 1901, attention was directed to the second part of Dr. A. W. Rowe's researches on the zones of the White Chalk. We have now had the satisfaction of receiving the third part of this most interesting and important work, which deals with the Chalk of Devon (*Proc.* Geol. Assoc., vol. xviii. part i., 1903).

Working the palæontology with such aids as can be gathered from the local stratigraphy and lithology, the author, assisted as before by Mr. C. D. Sherborn, has added extensively to our knowledge of the successive forms of life that are met with in the Chalk between Sidmouth and Lyme Regis. Whether or not the limits of the zones happen to coincide with definite stratigraphical limits, these latter afford useful data, and one marl band to which the author directs special attention, forms the plane of division between the zones of *Terebratulina gracilis* and *Holaster planus*. Such definite and continuous bands of rock (so far as they can be traced) must afford even more precise evidence of contemporaneity than the presence of this or that fossil. Even a tabular flint-band has proved "an almost constant feature throughout the coast"—an interesting fact, and one that was not to be expected. It is admitted that the name-fossils are not always confined to their zones. *Holaster planus* is found by Dr. Rowe throughout the zone of *Terebratulina gracilis*. But the guide-fossils, the general assemblages associated with the name-fossils, while they exhibit here, as elsewhere, local variations, tell the same story of the successive zones or stages of life, and indicate their approximate limits. Perhaps too much importance is given to the effort to fix a precise divisional plane between zones. When such divisions depend on the forms of life, and the succession of life is continuous though gradually varying, there can be no absolute planes of division, except through the absence or erosion of strata belonging to a particular period of time.

The work before us is rich in its stores of interesting facts. The zone of *Rhynchonella Cuvieri* presents noteworthy features in the presence of *Micraster cor-bovis* and *M. leskei*, the zone of *Terebratulina gracilis* is "singularly rich in fossils," while in the zones of *Holaster planus* and

Micraster cor-testudinarium the group-form of Micraster is almost wholly absent. Nor are the lithological deviations less noteworthy, for the particular characters of the Chalk vary at different stages, and the same division may be nodular or smooth, and have many or no belts of flints. The value of a detailed palæontological study of our strata is abundantly manifested in this essay, and not the least interesting part of it is in the light it throws on the geographical as well as geological distribution of the fossils.

A most excellent series of plates of cliff-sections, from photographs taken by Prof. H. E. Armstrong, accompany this work. H. B. W.

THE PHYSIOLOGY OF BREEDING.[1]

IT is a remarkable fact that the system of organs in the animal body to which they are themselves indebted for their existence is very largely neglected by physiologists; that a number of secretory, vascular and nervous phenomena intimately concerned with fertility, with the power of conception and the ability to bear young are neither understood nor investigated; and that a wide field of research as to the influences of various kinds of food supplied to the mother both on her capacity for breeding and on the growth, constitution, and variation of the embryo is as yet untouched. As a contribution to the subject of "breeding," therefore, this paper is specially welcome, and the author is to be congratulated both upon the careful work he has done and the treatment he has accorded the subject.

The wide variations in the power of breeding which different breeds of sheep and different individuals of the same breed are subject to is shown, and the effect of altitude, climate and food referred to.

The histological changes which take place in the uterus of the sheep during the œstrous cycle are carefully described and figured, and the homology of these changes with those elsewhere described for the bitch and monkey clearly established. A brief *résumé* of the author's work on the same phenomena in the ferret is given, and their essential similarity with that of the bitch shown.

Suggestive information follows on the question of ovulation in sheep and other mammals, on the stimulus necessary to bring about that process under various conditions, on the artificial methods adopted by some flock masters to stimulate breeding in their ewes, and on the effect of these methods on fertility. Here a subject is touched upon which is of vital importance to breeders, and one which requires and deserves careful study. Atresia among the follicles of the sheep's ovary is then studied, and its relation to the proportion of twins and to barrenness examined.

The remainder of the paper is occupied with a description of the formation of the corpus luteum of the sheep and an examination of the views of the most recent writers on that subject. The lutein cells are stated to be the much hypertrophied epithelial cells of the undischarged follicle, while the connective tissue element is supplied by ingrowth from both theca interna and externa.

Finally, the relation between the development of the corpus luteum and the changes which take place in the uterus during pregnancy is touched upon, and the view expressed that, while the functions of ovulation and œstrus do not represent cause and effect, they are primarily connected, inasmuch as each is dependent largely upon the same cause.

[1] "The Œstrous Cycle and the Formation of the Corpus luteum in the Sheep." By Francis H. A. Marshall. (*Phil. Trans.*, vol. cxcvi., 1903.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE new prospectus of the department of dyeing and tinctorial chemistry of the Yorkshire College, Leeds, shows that special facilities are provided for the study of the chemistry of the colouring matters and for research work upon coal tar products. An effort is being made to combine the standard of scientific teaching of a university with the practical training of a technical school, and to encourage the prosecution of original investigation in what is certainly the most scientific, yet unfortunately, in this country, the least studied branch of applied chemistry. The dyeing department was built, equipped, and endowed by the Clothworkers' Company, and is provided with lecture-rooms, pattern and diagram rooms, museums, experimental and practical dye-houses, as well as with adequate provision for research work.

THE Great Western Railway Company now offer facilities, in conjunction with the Swindon Education Committee, to their apprentices to enable them to gain technical scientific knowledge. A limited number of selected students may attend day classes at the Technical School. They must have spent at least one year in the factory, and must have regularly attended for at least one session in the preparatory group of evening classes at the Technical School. The number of studentships will be limited to thirty at any one time. For each year's course there will be a competitive examination, successful students passing on from one year's course to the next. The course of study for each year will consist of practical mathematics, practical mechanics, geometrical and machine drawing, heat, electricity, and chemistry. Those attending the classes will have their wages paid as if at work in the factory, and the Great Western Railway Company will pay their school fees. The students attending the day classes will be expected to give some time each evening to private study. Students who distinguish themselves will be allowed to spend part of their last year in the drawing office and chemical laboratory. The whole of the arrangements will at all times be under the direction of the chief mechanical engineer.

THE report on the secondary and higher education of the City of Sheffield, prepared by Prof. Michael E. Sadler, has been published in pamphlet form by the Education Committee of Sheffield. The schools and colleges now in existence in Sheffield are described and their work passed in review. A series of recommendations is then made with a view to equip the city with a complete educational system. Prof. Sadler says that the weakest spot in the educational arrangements of Sheffield is in the secondary education provided for boys. A promising boy ought to have the best educational opportunities within his reach, but at present the equipment of such higher education in Sheffield is very much behind the standard in the progressive cities of Germany and the United States. Dr. Sadler also recommends a development of the work of the Technical College. He remarks, "the work of the Technical College, admirable as it is, would greatly gain in force and depth if it were supported by a strong department of pure science." As the report rightly insists, what is wanted is that a workman should be able to deal with new problems, and in order to do this he must have, as a foundation for his technological skill, a thorough knowledge of the pure science which it is his task to apply to practical problems. The probable additional net annual cost to Sheffield of carrying out Prof. Sadler's chief recommendations is estimated at about 8500*l*., which would mean a rate of less than three halfpence. It now remains for the Education Committee of Sheffield to put into practice some of the excellent suggestions in the report.

THE volume of "General Reports on Higher Education for 1902," just published by the Board of Education, contains with other information of importance an account of the secondary schools, science classes, art classes, and evening schools of the southern and eastern divisions of England, the former by Mr. Buckmaster and the latter by Dr. Hoffert. Speaking of the evening schools in London, Mr. Buckmaster says "the impression formed in early visits has not been removed on more complete acquaintance, and the School Board, in its laudable anxiety to throw the educational net as wide as possible, has secured quantity at the expense of quality. As missionary agencies the schools abundantly justify their existence, they bring the opportunities for improvement near to all in all parts of the metropolis, but as centres for real solid work they are not so successful, in spite of the best efforts of the teachers, the majority of whom are most enthusiastic and devoted to their work." Several methods for the improvement of these schools are suggested, such as the alteration of the rule that, where the average attendance falls below 25 per teacher, a reduction in the number of teachers should be made; that

means should be taken to improve the attendance; and to encourage homework. The polytechnics are to some extent fed by students from these evening classes, and it is of importance that their work should be as serious as possible. Dr. Hoffert is able to report considerable progress in the organisation of higher education in the eastern division of England, especially the increased attention now being paid to the improvement of secondary education. In another place Dr. Hoffert refers to the question of higher elementary schools, and expresses the opinion that schools of this type might very profitably be distributed at suitable intervals over London. "They appear destined to fill an important place in any future organised scheme of elementary and secondary education, and to form the natural completion of the elementary system."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 18.—"Radiation in the Solar System: its Effect on Temperature and its Pressure on Small Bodies." By J. H. **Poynting**, Sc.D., F.R.S., Professor of Physics in the University of Birmingham.

PART I.—*Temperature.*

We can calculate an upper limit to the temperatures of fully absorbing or "black" surfaces receiving their heat from the sun, and on certain assumptions we can find the temperatures of planetary surfaces, if we accept the fourth power law of radiation, since we know approximately the solar constant, that is, the rate of reception of heat from the sun, and the radiation constant, that is, the energy radiated at 1° abs. by a fully radiating surface.[1]

The effective temperature of space calculated from the very uncertain data at our command is of the order 10° abs. Bodies in interplanetary space and at a much higher temperature may, therefore, be regarded as being practically in a zero temperature enclosure except in so far as they receive heat from the sun.

The first case considered is that of an ideal earth, more or less resembling the real earth, and it is shown that the temperature of its surface is, on the average, 325°, 302°, or 290° abs. according as we take for the solar constant Ångström's value 4 cal./min., Langley's value 3 cal./min., or a value deduced from Rosetti's work 2·5 cal./min. The lowest value found, 290° abs., is very near the average temperature of the earth's surface, which may be taken as 289° abs. As the earth's effective temperature must, if anything, be below this, and cannot differ much from that of the ideal planet, Rosetti's value for the solar constant, 2·5 cal./min. or $0 \cdot 175 \times 10^7$ ergs./sec. is probably nearest to the true value, and is therefore used in the following calculations.

The preceding calculations may be turned the other way. It is shown that, on certain assumptions, the effective temperature of the sun is 21·5 times that of the ideal earth. If we consider that the real earth with a temperature 289° abs. sufficiently resembles the ideal, we get a solar temperature $21 \cdot 5 \times 289 = 6200°$ abs.

The upper limit to the temperature of the surface of the moon is determined and is shown to be 412° abs. when no heat is conducted inwards. But Langley finds that the actual temperature is not much above the freezing point on the average. This leads us to the conclusion that it is not higher than four-fifths the highest possible value, the reduction being due to inward conduction.

The temperature of a small body, dimensions of the order of 1 cm. or less, but still so large that it absorbs radiation, is shown to be nearly uniform, and at the distance of the earth from the sun about 300° abs.

Under otherwise similar conditions temperatures must vary inversely as the square root of the distance from the sun. Thus Mars, if an earth-like planet, has a temperature nowhere above 253° abs., and if a moon-like planet, the upper limit to the temperature of the hottest part is about 270°.

PART II.—*Radiation Pressure.*

The ratio of radiation pressure due to sunlight to solar gravitation increases, as is well known, as the receiving body diminishes in size. But if the radiating body also diminishes in size, this ratio increases. It is shown that if two equal and fully radiating spheres of the temperature and density of the sun are radiating to each other in a zero enclosure, at a distance large compared with their radii, then the radiation push balances the gravitation pull when the radius of each is 335 metres. If the temperature of two equal bodies is 300° abs. and their density 1, the radius for a balance between the two forces is 19·62 cm. If the density is that of the earth, 5·5, the balance occurs with a radius 3·4 cm. If the temperatures of the two are different, the radiation pressures are different, and it is possible to imagine two bodies, which will both tend to move in the same direction, one chasing the other, under the combined action of radiation and gravitation.

The effect of Döppler's principle will be to limit the velocity attained in such a chase. The Döppler effect on a moving radiator is then examined, and an expression is found for the increase in pressure on the front, and the decrease in pressure on the back of a radiating sphere of uniform temperature moving through a medium at rest. It is proportional to the velocity at a given temperature. The equation to the orbit of such a body moving round the sun is found, and it is shown that meteoric dust within the orbit of the earth will be swept into the sun in a time comparable with historical times, while bodies of the order of 1 cm. radius will be drawn in in a time comparable with geological periods.

"The Phenomena of Luminosity and their possible Correlation with Radio-Activity." By Henry E. **Armstrong**, F.R.S., and T. Martin **Lowry**, D.Sc.

The possibility of regarding *luminous manifestations* generally—including radio-activity—as the outcome of oscillatory changes in molecular structure was pointed out by one of the authors more than a year ago in a communication to the Society in which the kind of change contemplated was exemplified by reference to the case of nitrocamphor. As the phenomena of radio-activity are exciting so much interest, it is thought desirable to enter somewhat more fully into an explanation of the argument underlying this conception of the origin of luminous appearances.

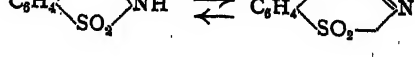
In the note referred to, it was suggested that *triboluminescent* substances, *i.e.* substances which become luminous at the moment of crushing, might conceivably, at the same time, manifest radio-activity. Sir William Crookes, at Dr. Armstrong's request, has recently examined saccharin from this point of view.

His remarks are described; they seem to show that saccharin is slightly radio-active towards barium platinocyanide when crushed. The authors have been unable hitherto to detect any effect on the electrometer.

Triboluminescence.—The authors consider the nature of the change involved in the production of the luminous flash, in order that it may be clear why, in their opinion, if radio-activity were observed in such a case, it would have been as the concomitant to chemical change.

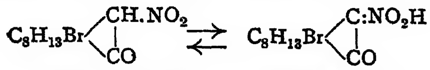
There is distinct evidence, they think, that the phenomena of triboluminescence may be correlated with the occurrence of the form of isomeric change which attends the passage of a compound into the isodynamic form of lower potential. Tschugaeff, who has examined more than 500 inorganic and organic compounds, found that about 25 per cent. of the latter gave a more or less intense flash when crushed; of these a considerable proportion appear to be such as could exist in isodynamic forms. Only about 5 per cent. of the inorganic substances flashed.

To take the case of saccharin, the two conceivable forms are:—



[1] W. Wien ("Cong. Int. de Physique," vol. ii. p. 30) has pointed out that Stefan's law enables us to calculate the temperatures of celestial bodies which receive their light from the sun, by equating the energy which they radiate to the energy which they receive from the sun, and remarks that the temperature of Neptune should be below −200° C.

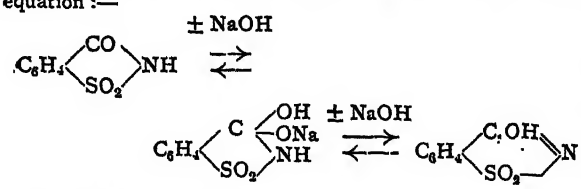
Comparable with these are the two isodynamic forms of π and β-bromonitrocamphor, for example:—



Normal neutral form. Pseudo-acid form.

In the solid state, both forms of π-bromonitrocamphor are stable; when either form is dissolved in a liquid, isomeric change sets in; sooner or later, it may be only in the course of a few hours or even days, a state of equilibrium is established, about 6 per cent. of the material being present in the pseudo form, and 94 per cent. in the normal form. The change, however, does not occur spontaneously, but is undoubtedly dependent on the presence of a catalyst, as equilibrium is established with great rapidity if a trace of alkali be added; acids have only a slight, although definite, accelerating effect. In the case of β-bromonitrocamphor, solutions in benzene of the neutral as well as of the acid form which have been kept during several days without undergoing change, when transferred to another vessel, have rapidly passed to a condition of equilibrium—doubtless because this vessel had been less successfully cleansed than that first used. It can, therefore, scarcely be doubted that the change occurs within a complex system—one which, it is only reasonable to suppose, constitutes an electrolytic circuit. The process is reversed when crystallisation sets in; if the evaporation of the solvent take place sufficiently slowly, the whole of the material is converted into and crystallises out in the less soluble form; if, however, evaporation take place rapidly, the isomeric change may lag behind the crystallisation and both forms may separate. In the case of nitrocamphor, the normal form is the one that separates from the solution; but in the case of π- and β-bromonitrocamphor, although the pseudo form is the minor constituent in the solution, being much less soluble than the isomeride, it is one to separate on crystallisation.

The passage of the one form into the other in the case of saccharin, for example, may be pictured as involving the occurrence of changes such as are represented in the equation:—



Supposing the stable form of lower potential to crystallise out, the crystals, in almost every case, would contain a minute and variable amount of the isodynamic form entangled, as it were, in the mass. In the solid, reversion to the stable form would take place very slowly. Presumably, however, sudden crushing of the crystals would afford opportunity for the change to take place and for the sudden *liberation of energy*—hence the momentary flash.

It is not, at present, necessary to assume that the phenomena are limited to cases of isomeric change; obviously, changes such as those considered may be regarded broadly as dissociative or reversible changes; and from this point of view, it is sufficient to regard the phenomena as the outcome of a loss of potential consequent on the passage from an unstable to a stable system.

From the point of view here advocated, it would be impossible to construct a condenser from a *pure* dielectric; and if the dielectric of a charged condenser were suddenly smashed under suitable conditions, it might exhibit the phenomenon of triboluminosity and perhaps radio-activity.

Fluorescence.—It was originally suggested by one of the authors, in discussing the origin of visible colour, that fluorescence is the "beginning of colour." Subsequently, Dr. J. T. Hewitt, in a paper on the relation between constitution and fluorescence, published early in 1900, took the important step of associating the appearance of fluorescence not with the mere occurrence of the quinonoid type of structure, but with the continued *development* of such a structure—in other words, he has regarded it as the outcome of oscillatory changes in the course of which a non-quinonoid compound undergoes conversion into the isodynamic quinonoid compound.

According to Hewitt, "all the molecules will be undergoing tautomeric change continuously and frequently, and energy absorbed when the molecules have one configuration will be, to an appreciable extent, emitted when they correspond to the other configuration. It is practically certain that the vibration frequency of fluorescein is different in the two states, and hence every opportunity is offered for energy of a rapid vibration frequency to be largely transformed into energy of greater wave-length."

Hewitt obviously does not regard fluorescence as a "flash phenomenon," but as a form of colour, as it were.

While agreeing with Hewitt that the origin of the effect is to be sought in the occurrence of reversible changes involving the production of dynamic isomerides, the authors think that fluorescence is to be regarded as something apart from colour, which, more often than not, is superposed upon colour. The character of the colour effect in fluorescence is quite distinctive; it is not only remarkable on account of its intensity, but there is in it an indefinable qualitative difference which seems to separate it from ordinary colour. If regarded as a "flash phenomenon" this difficulty disappears.

Hewitt appears to regard fluorescence as the outcome of mere intramolecular wobble. To the authors it seems likely that the change is conditioned by a catalyst, and that it occurs within a complex electrolytic circuit.

Phosphorescence.—The phenomena of phosphorescence need to be considered with reference both to cases in which the manifestation attends oxidative or other kinds of chemical change (the glow of phosphorus, the glow-worm, phosphorescent bacteria) and to those in which it is induced by exposure to light (luminous sulphides). The former might well almost be regarded as cases of fluorescence, as a continual supply of energy is derived from the continued occurrence of a chemical change involving loss of energy. With regard to the latter, it would seem that it is not a property of pure substances.

The phosphorescent medium may be pictured as a complex system capable of undergoing "electrolytic" deformation under the influence of light of high refrangibility; as the changes thus induced are reversed, the energy stored up during insolation becomes liberated, and the persistence of the effect is but a consequence of the fact that the change takes place under restraint in a viscous medium.

Dewar's remarkable observations on phosphorescence at low temperatures clearly foreshadow the conclusion that the property is to be correlated with structure.

Radio-Activity.—Pursuing the argument a stage further, it appears to the authors justifiable to regard the activity of radium tentatively as but an exaggerated form of fluorescence in which radiations unnoticed by substances generally—capable of penetrating substances generally—become absorbed and rendered obvious. Such an explanation, from the chemist's point of view, is at least as rational as one which assumes that nature has endowed radium alone of all the elements with incurable suicidal monomania.

There seems to be no good reason for assuming that in fluorescent and other ordinary substances we possess screens capable of arresting rays of every conceivable kind; it may well be that our knowledge of solar radiations is not yet complete.

With regard to "thorium and thorium X," the facts, as stated by Rutherford and Soddy, do not seem to be incompatible with the view that these are but isodynamic forms of thorium or their equivalent, their behaviour being very similar to that of the isodynamic forms of nitrocamphor. In any case, it appears desirable to approach the problem from this point of view, and to investigate the phenomena far more thoroughly on the chemical side.

Whatever the ultimate value of the considerations advanced in the note, they at least serve to show that much may be learnt by further study of the extent to which luminous phenomena generally are to be correlated with structure and structural changes.

July 21.—"On the Oxidising Action of the Rays from Radium Bromide as shown by the Decomposition of Iodoform." By W. B. **Hardy**, F.R.S., Caius College, Cam-

bridge, and Miss E. G. **Willcock**, Newnham College, Cambridge.

A solution of iodoform dissolved in chloroform rapidly becomes purple owing to the liberation of free iodine. This reaction, which seems not to have been previously described, takes place in all the solvents tried, namely, chloroform, benzene, carbon bisulphide, carbon tetrachloride, pyridine, amyl alcohol, and ethylic alcohol, but oxygen is always necessary to the change.

The decomposition of iodoform in solution is not, as it at first sight appears to be, a spontaneous change. It is due ordinarily to the action of light. The solvent has a great effect on the rate of decomposition—the solution in chloroform is very sensitive, that in benzene relatively stable. The solution in chloroform furnishes a delicate test for oxygen and for obscure radiations. It suffers change in gas light, faint daylight, and in X-rays or radium rays. The intensity of the action can easily be measured in time units by choosing some standard colour and matching the fluids under examination with it.

The action of light is due to the ordinary light waves, that is to say, any opaque screen completely arrests the action even of sunlight. Solutions in chloroform enclosed in opaque cardboard boxes have remained unchanged near a window for four days.

The action of radium is due to the more penetrating rays. By screening off the various rays, it can be shown that the α rays have no influence—the oxidation appears to be due solely to the β and γ rays, that is, to the negative electrons (β rays) and to the very penetrating ethereal waves (γ rays), which are said to be identical with X-rays. The action of the radium rays, therefore, will take place through as much as 8mm. of lead, though, of course, relatively very slowly, owing to the stopping of the β rays.

Some idea of the intensity of the action of radium may be obtained from the fact that a solution in chloroform in an ordinary test tube is changed to deep purple in twelve minutes by resting the point of the tube upon a mica plate covering 5 milligrammes of radium bromide. Radium rays, however, are much less active than daylight, as is shown by the fact that the more stable solution of iodoform in benzene resists their action for forty-eight hours, though it becomes purple in about fifteen minutes in the least lighted part of an ordinary room. Seeing that the thinnest opaque screen seems completely to stop the active rays of sunlight, it is obvious that sunlight, as it reaches the surface of the earth, can contain at the most exceedingly few β and γ rays.

M. Blondlot has described recently the presence in sunlight of certain rays which traverse metals but are arrested by water (N rays). These rays have no detectable action upon iodoform; the action of sunlight is not delayed appreciably by interposing a water screen many inches in thickness, and the action is completely arrested by even an opaque deposit of lampblack or by aluminium foil.

The fact that light waves[1] exert a chemical activity more intense than that of radium rays compels us for the present to refer the profound, and often lethal, physiological action of the latter to their power of penetration rather than to any novel or peculiarly intense action upon the tissues. They reach parts which ordinarily are shielded by a cuticle impervious to light waves.

One of us has already shown that the α rays profoundly modify the *physical* state of colloidal solutions (*Journal of Physiology*, vol. xxix. p. 29). If the colloid particles be electrically negative, the α rays act as coagulants; if the colloid particles be electrically positive they act as solvents, that is to say, the rays decrease the average size of the particles.

As a provisional basis for the investigation of the physiological action of radium rays, we may therefore regard the α rays as altering the physical state of the living matter, the β and γ rays as altering the chemical processes, especially, perhaps, the oxidation processes of the tissues.

[1] Including, of course, the ultra-violet waves. Hardy and D'Arcy have shown that the production of "active" oxygen by light falling upon a moist surface is limited in the spectrum to rays from the ultra-violet to the blue end of the green (*Journal of Physiology*, xvii. 1894, p. 390).

PARIS.

Academy of Sciences, August 24.—M. Albert Gaudry in the chair.—Batteries with several different liquids, but identical metallic electrodes, by M. **Berthelot**.—Observations of the sun made at the Observatory of Lyons with the Brünner 16cm. equatorial during the second quarter of 1903, by M. J. **Guillaume**. Observations were possible on sixty-seven days during the quarter; the results are given in three tables showing the number of sun-spots, their distribution in latitude, and the distribution of the faculæ in latitude.—On the problem of S. Lie, by M. N. **Saltykow**.—On the Fourier-Cauchy integrals, by M. Carl **Störmer**.—On the function of the metallic core in induction coils, by M. B. **Eginitis**. The effect of the core varies with its shape, material, the temperature of the sparking poles, their nature and explosive distance, and also on the self-induction of the coil.—On the constitution of the phospho-organic acid in the reserve material of green plants, and on the first reduction product of carbonic acid in the act of chlorophyll assimilation, by M. S. **Posternak**. The acid, heated with dilute mineral acids, is quantitatively hydrolysed into inosite and phosphoric acid. From this, and its cryoscopic behaviour in aqueous solution, the formula $O[CH_2.O.PO(OH)_2]_2$, the anhydride of oxymethylene-diphosphoric acid, is given to the substance, and conclusions are drawn from this as to the nature of chlorophyll assimilation.—On the general equation of curves of fatigue, by M. Charles **Henry** and Mlle. J. **Joteyko**.

CONTENTS. PAGE

THURSDAY, SEPTEMBER 10, 1903.

RECENT MINERALOGY.

Mineralogy: an Introduction to the Scientific Study of Minerals. By Henry A. Miers, D.Sc., M.A., F.R.S. Pp. xviii + 584; with two coloured plates and 716 illustrations in the text. (London: Macmillan and Co., Ltd., 1902.) Price 25*s*. net.

THE author of this work has various qualifications for the difficult task undertaken by him, a task which has occupied the leisure hours of many years of an otherwise busy life. For thirteen years he was closely associated with the most beautiful and extensive of mineral collections; during that time he became thoroughly familiar with such objects as are described in his book, and attained scientific distinction by reason of the thoroughness and delicacy of his varied scientific researches; further, he visited not only all the best collections in the world, but also many noted mineral localities, and viewed the specimens in their own homes. He introduced, and for several years taught, the subject of crystallography to the students of the City and Guilds Technical Institute, invited thereto, and encouraged therein, by that far-seeing and enthusiastic chemist Prof. Henry Armstrong; he thus prepared the way for the brilliant discoveries since made by his crystallographic pupil Dr. Pope, and at the same time not only became familiar with the difficulties met with by students, but was compelled to discover the best ways of surmounting them. During the last eight years he has been at Oxford as occupant of the Waynflete chair of mineralogy, in succession to the veteran mineralogist and crystallographer Prof. Maskelyne, and by his development of mineralogical study in that university has more than justified his appointment.

The volume, though announced to be merely "an introduction to the scientific study of minerals," immediately impresses even a superficial observer with the magnitude of the subject, for its pages are at once large and numerous (584). But the reader, on opening it, instead of being immediately repelled by the obvious details and technicalities of a difficult subject, is at once attracted by the artistic character of the workmanship, for both paper and type are excellent, and the pages are adorned with no fewer than 716 illustrations, most of them of a style to which we are quite unaccustomed. Every artist knows the difficulty of making even a fair representation of the aspect of minerals, and both authors and students have thus had to remain content with mere diagrammatic figures in illustration of mineral "habit." In this case the author has been able to make many experiments by presuming on his relationship and exercising the artistic patience of a sister; as a result, they have evolved a series of figures most of which leave little to be desired; these are process reproductions of shaded drawings of actual, not imaginary, specimens, and, through the emphasis given by the artist to the leading lines of the figures, are as good substitutes, in two dimensions, for the actual specimens as can be wished. Among the most striking are Figs. 402, flos ferri; 407, calcite showing conchoidal fracture and cleavage; 422, diamond; 437, cryolite; 447, blende; 478, corundum; 486, rutile; 506, quartz twinned; 519, chrysoberyl; 554, witherite; 587, chiastolite; 627, harmotome. For the diagrammatic figures of crystals, the author is indebted partly to the same artist, Miss J. Miers, and partly to the assistant, Mr. R. Graham, whom he has trained in crystallography and perhaps represented, on p. 263, in the very act of crystal measurement. Further, there are two coloured plates which have been executed at the Oxford University Press by the three-colour collotype method, and are the outcome of much experiment; unfortunately, the method is as yet found to be too costly for general use. One of these plates represents the simple biaxial figure shown by a section of an orthoclase crystal when viewed in the polariscope by blue, green, and red monochromatic lights respectively; the other represents the complex figure yielded by the same section when viewed by white light. The actual chromatic effect of the "inclined dispersion" so characteristic of the mineral is thus beautifully reproduced by photography instead of being diagrammatically represented, as is usually the case, by a more or less plausible arrangement of colours. The trouble taken, and the expense incurred, to obtain this result are characteristic of the book in general.

The author himself points out that the treatise is no exhaustive introduction to the study of mineralogy, and that he has deliberately abstained from giving a systematic account of the modes of occurrence of minerals, their geological distribution, their origin, their alterations, and their artificial production. Indeed, the account and discussion of the essential characters of only the more prominent of the minerals which are so common as to be found in all museums occupies a volume which, to put it mildly, is quite as large as a student of average strength can conveniently carry about and handle; the other subjects are of necessity left for treatment in one or more later volumes.

The present volume is divided into two nearly equal parts; the first deals with the properties of minerals in general (286 pages); the second gives a description of the more important species (244 pages); these are followed by 28 pages of tables and a most elaborate and useful index (22 pages). One of the tables gives in a compact form a classified arrangement of the mineral species and a simple chemical formula for each, thus enabling the mind to grasp more readily some of the chemical relationships of the species. Of the tables useful in the practical determination of minerals, the most noteworthy are those giving the arrangement of the species according to the increasing magnitude of the mean refractive index, the birefringence, the optic axial angle, and the specific gravity respectively.

Part i. is subdivided into four books, treating of (1) crystalline properties (179 pages); (2) general properties (23 pages); (3) relations between the properties (30 pages); (4) description and determination of minerals (44 pages). Of the three latter and shorter

books, the second contains a chapter on the chemical properties, more especially with regard to the problem of the classification of species; the third contains several articles which have not previously found their way into text-books of mineralogy (pp. 228–41); they relate to the crystalline form and physical properties of "solid solutions," and are especially useful in the discussion of the felspars; the fourth contains a chapter on the determination of minerals, and affords many useful and practical hints suggested by a long experience.

The first book is by far the longest, and is itself divided into two nearly equal sections; the first (98 pages) deals with the geometrical properties of crystals, the second (81 pages) with their physical properties. It may be objected that it is impossible to give to the student, within the compass of 98 pages, an adequate idea of the theory of crystallography, but it must be remembered that, in a work on mineralogy, minute crystallographic detail would be out of place; such detail is already given to the student in the special treatises of Prof. Maskelyne ("The Morphology of Crystals"), of Prof. Lewis ("A Treatise on Crystallography"), and of Mr. Hilton ("Mathematical Crystallography and the Theory of Groups of Movements"). What the mineralogical student requires is a brief sketch of the whole subject to enable him to grasp the general bearings; this the author has given, and it is all that should be expected from him. It may be mentioned that the author has sought to bring about uniformity of nomenclature of the thirty-two classes of symmetry by coming to an understanding with Prof. E. S. Dana, the editor of the well-known "System of Mineralogy"; but notwithstanding their agreement we find it difficult to reconcile ourselves to a nomenclature which compels one to say that a crystal of cinnabar (HgS) belongs to the quartz class; the systematic nomenclature suggested on p. 280 seems more full of promise. Attention may be directed to the form of student's goniometer, as improved by the author, which is figured on p. 101, and also to the convenient goniometer designed by him for fixing on the stage of a microscope (p. 178).

The chapters treating of the optical properties (70 pages) will probably be the most generally appreciated by students, owing to the great use made of these properties in the determination of the mineral constituents of rock-sections by means of the polarising microscope. It gives to the student a sufficiently precise sketch of the subject without entering into mathematical discussions, and proves once more that it is possible to give to the student an idea of the optical characters of biaxial crystals without any unsatisfactory hypothesis as to optical elasticity and its variability with crystallographic direction.

Part ii., which gives a description of the more important mineral species, is subdivided merely into sections dealing with the various mineral groups. It differs from other works of a similar kind in that it is in great part readable, instead of being a mineralogical dictionary. The readable part and the dictionary part are kept quite distinct from each other, both in position and in the size of type. Further, there is no attempt to give long lists of localities; these are left to be sought for in the books of mere reference; the author is satisfied, and doubtless the student will be satisfied, with descriptions of specimens from the more noteworthy localities, and with accounts of the more important modes of occurrence, and of these we think the author has made a judicious selection. As for the readable portion, it is full of interesting and valuable information.

The author has a simple and pleasant style which attracts the reader, occasionally relieving the technicality with a touch of the driest humour, as, for instance, when he finds it convenient (p. 350) to treat dihydric oxide as a member of an anhydrous series.

The English student of crystallography and mineralogy is to-day in a happy position as compared with his forerunners; his path is continually made more and more easy by the publication of excellent text-books; but there will long remain sufficient inherent difficulty to prevent these subjects of study from losing their educational value, and, as regards research, the recent discovery of radium in the long-known mineral pitchblende shows that the statement made by the alchemist several centuries ago is still true—"a man may consume his whole life in the study of a single mineral without arriving at the knowledge of all its qualities."

SCHOOL MATHEMATICS.

A Junior Geometry. By Noel S. Lydon. Pp. vi+171. (London: Methuen and Co., 1903.) Price 2s.

Technical Arithmetic and Geometry. By C. T. Millis, M.I.M.E. Pp. xiv+254. (London: Methuen and Co., 1903.) Price 3s. 6d.

The Modern Arithmetic for Advanced Grades. Woodward Series. By Archibald Murray (Harvard). Pp. 464. (St. Louis: Woodward and Tiernan Printing Co., n.d.)

The Junior Arithmetic, being an Adaptation of the Tutorial Arithmetic, suitable for Junior Classes. By R. H. Chope, B.A. Pp. viii+363. (London: W. B. Clive, 1903.) Price 2s. 6d.

MR. LYDON'S book, which is meant for young pupils, has many good points and a few bad ones. Like many other very recent books on geometry, it ignores Euclid's order, method, and language. In this way it appeals more readily to the understanding of the pupil than the orthodox Euclidean works do; but the definition "a straight line is one which lies 'evenly' between its extreme points," and the words "notice that the line you have ruled lies evenly between its extreme points A and B," show a strong conservatism. The pupil will indeed be clever if he can give a clear indication of the thing which he notices. The use of the terms *vertical* and *horizontal* in the following manner must be very strongly condemned:—

"When a straight line is drawn upright on the paper it is called a *vertical* line, when drawn in a slanting direction it is called an *oblique* line, and when drawn level on the paper it is called a *horizontal* line."

Early teaching of this kind is responsible for the flagrant misuse of the terms *vertical* and *horizontal*

which is so frequently exhibited by draughtsmen and students of engineering.

Again, the definition of an angle—"an angle is the difference in direction of two lines drawn from a point"—has nothing really quantitative about it, and should be used rather as a familiar *description* than as a quantitative definition.

After the definition of parallel lines—"parallel lines are such as are the same distance apart throughout their whole length"—we have the warning "be careful to distinguish between parallel and horizontal," which unintelligibility is, doubtless, in some way connected with the strange conception of *horizontal* above noticed.

We are now done with the blemishes; for the rest we have nothing but commendation. The book is divided into a series of lessons, each of which is followed by several exercises in the copying of various figures and patterns on squared paper, accompanied by arithmetical calculation. The little pupil is led easily into the subject, and he meets with nothing like severe reasoning until lesson vii. is reached. The grouping of propositions and constructions is throughout very good, and the chapters on areas particularly excellent. The most useful propositions of Euclid's books ii. and iii. are included, and the concluding lessons deal with loci, ratio and proportion, similar figures, &c., and include a large number of important problems, theorems, and constructions. This portion of the book (the most important) can scarcely be improved upon, and, indeed, for this part of the subject, we do not know of any work for beginners which deserves higher commendation.

The book by Mr. Millis can be very strongly recommended as one the study of which should go hand in hand with that of books on purely deductive geometry. It begins with the definitions and figures of geometry, and the use of instruments for the solutions of the problems which are usually treated of in geometrical drawing. Then follows the treatment of fractions, vulgar and decimal, their nature being explained and illustrated by geometrical construction. Contracted methods of multiplication and division are explained. The nature of ratio and proportion follows, and then the enlargement and reduction of figures, square root, propositions relating to areas—in the whole of which work arithmetic goes hand in hand with geometry. After the usual figures of elementary plane geometry are dealt with, conic sections and irregular curvilinear figures are taken, and their properties illustrated by arithmetical examples, with the use of squared paper. Simpson's rule and Henrici's method are explained. The last third of the book deals very fully with the mensuration of solids.

The pupil who uses this work will receive a thorough drilling in neat and accurate drawing—a thing which was very much needed when Euclid held sole sway in the schools.

Mr. Murray's book is a sequel to the work which we noticed some months ago. It is meant for teachers, inasmuch as no answers are given to the various questions. Comparing the work with either of the two books on arithmetic now noticed, it would appear that in the American schools the subject is taught in a very leisurely manner, since there is nothing of a very advanced nature in this work, and a great deal of the mere elements is included. This, of course, may in the end make for thoroughness. It seems somewhat strange that addition and subtraction of decimals are employed in the beginning (p. 31, &c.), while the subject of decimals is subsequently taken (p. 127, &c.) and treated *ab initio*.

Arithmetic and a certain amount of elementary algebra go hand in hand in the book—an arrangement which makes things simple for the beginner; but the purpose of several pages on very elementary algebra at the end of the chapter on percentage is not clear.

The metric system is, of course, explained and illustrated, but the large amount of space devoted to English weights and measures, with their antediluvian lawlessness and complexity, induces sad reflections on the utter waste of time which we impose upon our youth.

The chapter on "Computations and Approximations" contains a useful exposition of the use of squared paper for the plotting of curves and the determination of missing values by graphic interpolation. As compared with our English works, the most striking characteristic of this book is, perhaps, the absence of complexity and useless difficulty in the various examples. It is a merit of the author that he is very particular about the accurate use of language—a great desideratum in these days of slipshod writing, when English grammar and a logical arrangement of thought are steadily vanishing from our scientific treatises.

Teachers everywhere will find the work very helpful and suggestive for a natural and logical way of teaching the subject to young pupils, inasmuch as the methods employed are the result of many years' practical experience in the work of instruction.

Mr. Chope has prepared a treatise of the usual kind on arithmetic. It contains a very large collection of examples illustrating the various rules, and is just as good a handbook of the subject as the student can desire.

THE NEURONE THEORY.

Die Neuronenlehre und ihre Anhanger. By Dr. Franz Nissl. Pp. vi+478. (Jena: Gustav Fischer.) Price 12 marks.

ONE approaches this work with rather mixed feelings. While there is no doubt that an exhaustive survey of our present knowledge in any branch of science is certain to well repay the investigator, yet a book of the magnitude of the one now under consideration, which contains only a controversial view of already known facts, without introducing anything beyond what is familiar to us, leaves on the mind of the reader something of a feeling of weariness, and a suspicion that the same amount of labour would have been better expended in quarrying fresh knowledge rather than reshaping the blocks that have been already brought out. The author himself has realised this, and in the preface gives the reasons which induced him to give the present form to the

book. That even scientific men are too prone to take a plausible hypothesis as proved, and to fill in the little gaps in the observed facts with more or less probable assumptions, is unfortunately true in many branches of research besides the one in question, and the work even of an *advocatus Diaboli* may be of value if only to point out the places in the theory where these assumptions occur. Particularly has this been the case in the domain of nerve physiology, and the present volume is a useful corrective.

The earlier part of the book is occupied with a historical review. Commencing with Waldeyer, His and Forel, Dr. Nissl gives an account of the origin and development of the neurone theory, with the various additions, alterations, and subtractions made by Hoche, Münger, Verworn, and the other investigators who have treated the subject. Allowing for a little very pardonable controversial bias, the summary is a just and able one, and Dr. Nissl's comments are well conceived; so that, although there are a few points on which different opinions may be held—for example, as to the weight to be attached to the work of Forel—yet, as a whole, we may take the history of the neurone theory here presented to us as the most complete and trustworthy one yet published.

The latter part of the book contains the author's reasons for dissenting from the generally received opinion of the structural unity of the elements known as "neurones." He points out that the idea of contact of nerve elements as opposed to that of continuity is not necessarily dependent on the neurone theory, and that the present methods of microscopic technique are not sufficient to give a final answer in the matter. The conclusion is therefore not so much that Dr. Nissl's own views are necessarily correct as that the rival opinions of the authors already mentioned have not sufficient basis in observed facts, and should be received with very much more reserve than has commonly been the case. It is not, however, possible to give a fair abstract of Dr. Nissl's contentions within the compass of a review, and the book itselt must be consulted for further details. It will be found to well repay careful reading, though the unwieldy size, the absence of an alphabetical index—partly made up for by very full chapter-headings—and the fact that, following the German custom, the author has given no summarised conclusion, render it difficult without considerable labour to disentangle the essential from the non-essential portions of the treatise.

OUR BOOK SHELF.

The Cloud World, its Features and Significance. By Samuel Barber. Pp. xii+139. (London: E. Stock, 1903.) Price 7s. 6d.

In this volume Mr. Barber's object has not been to write a scientific treatise on cloud formation, but rather to put before us his own carefully made observations, and "to commend to the tourist, the cyclist, and the city man a delightful and refreshing field of study which may add a charm to a summer holiday." With this object the book has been illustrated with a large number of excellent photographs and sketches, and contains many hints on the prognostic value of different appearances of the sky. We cannot help thinking that it would have gained in value if Mr. Barber had added, or, better still, prefaced, a short chapter on the classification of clouds adopted by the International Committee. This would have familiarised his readers with the generally accepted terminology of the subject; the glossary partly answers this purpose, but it enumerates so many different cloud forms that it might become confusing to one entirely unfamiliar with the subject.

When dealing with the physics of the atmosphere Mr. Barber is distinctly less happy. Though the book is not a scientific treatise, it ought not to contain statements such as the following.

In discussing the question of the suspension of water particles in the atmosphere we read, "The mechanical problem is exactly analogous to that of a bird's flight. If the bird is shot it drops for want of a propelling force: just so with the water vapour. It is not sufficient to assume the vesicular form of water in cloud molecules; we should need to assume a higher temperature in the air enclosed by the vesicles than in the surrounding atmosphere. How can this be maintained, especially at great elevations?" The hypothesis that clouds consist of hollow water vesicles received its death blow about the middle of last century when Stokes calculated the limiting velocity of a falling drop; since that date the suspension of water globules in the atmosphere has ceased to be a stumbling block to physicists. A few pages later we find the statement, "Various forces affect water and ice particles; *e.g.* heat, electricity, gravity between particles, gravity towards mountains and other prominences, gravity to the earth, and last, but not least, the force of crystallisation. . . . Let anyone watch the formation of ice crystals on still water, and he will have an idea of the extent of this force." Are we to understand from this that "gravity towards mountains" affords an explanation of the tendency of clouds to form near the summit of a mountain?

The reader who is inclined to make the study of the appearance of the sky his hobby will find much to interest him in the descriptive part of the book, but he must be prepared to take many of the physical explanations it contains *cum grano salis*.

Graphical Statics Problems, with Diagrams. By W. M. Baker, M.A. Pp. 60. (London: Edward Arnold, n.d.) Price 2s. 6d.

This is a compilation of sixty problems in graphical statics, many of them taken, by permission, from the army entrance examination papers. Each problem is accompanied by a diagram, and has a separate page allotted to it. This leaves plenty of room for the problem to be worked graphically on the page itself, without requiring the diagram to be transferred to drawing paper. The pages are perforated, and are easily removed if desired.

There is, perhaps, some unnecessary repetition and not enough diversity in the problems. We would suggest for a future edition that problems be included involving a direct appeal to experiment in verification of the principles of the polygon and the lever; and the scope of the subject might well be extended by the introduction of position, displacement, velocity, and momentum vectors, including vector differences, thus helping very materially to an adequate understanding of Newton's great law. Students should always measure their graphical results, and an appendix containing numerical answers would have been found very useful in this connection.

But the design of the book and the arrangement of the problems greatly facilitates the work of the teacher, and the volume can be strongly recommended to all who wish to include this very important branch of geometry in their curriculum.

LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Mite whose Eggs survive the Boiling Point.

IN several preparations of boiled flax seeds for fungus-culture it was observed that numbers of mites (*Tyroglyphus histiostoma*) made their appearance. A petri dish containing mites was boiled, and in about three weeks there were again large numbers of them present, though the cover had never been removed since boiling.

On June 6 a decoction of flax seeds containing mites in a test tube was boiled for five minutes, and the neck plugged with cotton wool. On June 15 a similar preparation was made, but the test tube was covered with an indiarubber cap in addition to the plug of cotton wool. On August 24 both test tubes contained living mites. So the inference seems justified that the eggs, though saturated with water, must have survived the boiling point.

The mite is about 2/5mm. in length. The bean-shaped eggs ($108{\cdot}5\mu \times 66{\cdot}5\mu$) are enclosed in two transparent valves like watch glasses.

I am much indebted to Mr. G. H. Carpenter for identifying the species. J. ADAMS.

Royal College of Science, Dublin, September 2.

THE BERLIN CONFERENCE ON WIRELESS TELEGRAPHY.

WE have on two or three occasions referred in these columns to the International Conference on Wireless Telegraphy which was held last month at Berlin. The conclusions at which the conference arrived have now been published in the *Cologne Gazette*, and were summarised in the *Times* last week. In considering these conclusions it is as well to bear in mind that the conference was only preliminary; though representatives of nearly all the important States were present, it was not intended that the recommendations should be final, but rather that they should serve as a basis for discussion at a future conference with more definite powers. Still, the decisions are of interest as they indicate more or less clearly the general state of opinion on the present position of wireless telegraphy.

We have frequently pointed out in NATURE that for the present at any rate it should be the aim of those directly interested in the development of wireless telegraphy to perfect it as far as possible as a means of communication between ships at sea and between ship and shore. This is really an infinitely more important object than the more ambitious and more striking attainment of Transatlantic communication, and such seems to have been the opinion of the conference. Within the last few days it has been announced that Mr. Marconi is now practically in a position to reopen Transatlantic communication on a commercial basis, but even if the attempt proves successful on this occasion less will have been gained than seems to be the case at first sight. We have already means of communicating telegraphically across the Atlantic, and though wireless telegraphy may add another, and possibly a cheaper, method, the gain will be trifling compared with the advantage of perfecting it in a direction in which we have no other resources, whereas should the working of the high power long-distance stations in any way interfere with or hinder the development of the less pretentious short-distance signalling, the loss to the community generally will be very great. Unfortunately, the actual condition of affairs at the present time is difficult to determine; important facts are kept quiet for what are doubtless sound commercial reasons, and assertions and counter assertions are rife. On the one hand we are assured that the big stations do not interfere with the small ones, and on the other we have undeniable evidence that these monstrous etheric disturbances may affect all apparatus in their neighbourhood. It may be possible to avoid this interference by suitable adjustment, but it ought not to be permissible to make this necessary any more than it should be permissible for a factory to belch forth smoke from its chimneys on the ground that those who wish for cleanliness and health can move their firesides to the country.

Wireless telegraphy, indeed, presents a somewhat peculiar and difficult problem; in the first place its medium of communication is one to which all people have an equal right, and which, therefore, one person or set of persons must not be allowed to use to the detriment of others; secondly, its utility depends directly on its availability under all conditions, and at all places, so that to be most useful there must be either a world monopoly or else a perfectly free interchange between competing systems. The second consideration is a strong argument in favour of State monopoly of any means of communication, whilst the first is an additional reason for international control of wireless communication. At the same time it is naturally unjust that those who have spent time and money and energy in pioneering development should be deprived of the legitimate reward of their labours. It is obvious that a solution to the difficulties is only to be found by a fair compromise between conflicting interests, that of the public at large on the one hand and those of the various wireless telegraphy companies on the other. The resolutions of the Berlin conference indicate the only way we can see in which such a compromise can be arranged. Two of these, which are concerned with rates and the method of charging, are not of particular importance; the others propose that coast stations shall be obliged to receive and forward all telegrams from vessels at sea by whatever system transmitted, that telegrams referring to wrecks or calling for assistance shall have precedence, that stations shall be arranged to give the minimum of interference, and that any necessary technical details of the working of apparatus shall be published. The first of these is naturally the most important, and at the same time is the one which it will be most difficult to ratify. It is, of course, well known that the Marconi Company has refused to acquiesce in such an arrangement, by which, as far the largest and most powerful wireless telegraphy company, they have least to gain and most to lose; their position as undeniably the pioneers of practical wireless telegraphy entitles them to special consideration. For this reason the delegates of Italy and Great Britain did not sign this recommendation. The Italian Government is bound by a fourteen years' agreement with the Marconi Co., so that all the delegates could do was to undertake to suggest to the company the amendment of the agreement in the desired direction. The British Government is in an almost equally difficult position, for the Marconi Co. is a British company, and holds already a practical monopoly in this country. Still, it is to be hoped that these difficulties will not stand in the way of an ultimate settlement. There is not unnaturally a suspicion that so far as other countries are concerned there is a desire to benefit, if possible, by

the organisation which the Marconi Co. has built up, and to enable home-bred systems to reap some of the reward of the enterprise of others. To a certain extent this is unavoidable, but it should be possible to arrange matters so that little or no injustice is done to the Marconi Co. whilst securing to the public the very fullest benefit that wireless telegraphy can confer, and it must not be forgotten that the interests of the British public, especially where shipping is concerned, extend all over the world.

MAURICE SOLOMON.

THE SOUTHPORT MEETING OF THE BRITISH ASSOCIATION.

THE seventy-third meeting of the British Association was opened yesterday, when the President, Sir Norman Lockyer, K.C.B., F.R.S., delivered his address in the Opera House.

Everything points to a highly successful meeting, though the number attending will probably fall short of that of the previous Southport meeting twenty years ago. In other respects, however, this year's meeting will probably surpass in interest that of 1883. The second edition of the local programme shows some additional arrangements made since our last article.

The list of excursions is given in greater detail, and a dredging excursion has been added on Thursday, September 17. A good deal of interest is being manifested in the motor car excursion on Saturday afternoon to Hoole and Rufford. A number of Southport gentlemen have placed their cars at the disposal of the local committee, and the show of automobiles will in itself attract attention. The excursion has a further interest, as Hoole is being visited, so that an opportunity may be given of seeing the place where Jeremiah Horrocks, the astronomer, lived at the time of his observation of the transit of Venus. A proposal has recently been mooted in Liverpool and Southport to erect a memorial to Horrocks, and a good deal of attention has been given to the Lancashire astronomer in the local Press. The Liverpool Corporation has kindly lent Mr. Eyre Crowe's picture of Horrocks at Hoole to the Southport committee, and it will be exhibited in one of the reception rooms during the meeting. The accuracy of Mr. Crowe's delineation of Horrocks's astronomical apparatus having been disputed, a Southport gentleman who has made a special study of Horrocks and his works has had painted by a local artist a picture representing the same subject depicted by Mr. Eyre Crowe, and the two pictures will hang in the same room.

The dredging excursion arranged for Thursday, September 17, is being organised by Prof. Herdman, and has been made possible through the courtesy of Mr. R. Dawson, the superintendent of the Lancashire and Western Sea Fisheries, who has kindly put the Sea Fisheries steamer, *John Fell*, at the disposal of the local committee for that purpose.

It is yet uncertain whether the kite-flying experiments for investigating the upper atmosphere can be successfully carried out at Southport. As mentioned in our issue of August 13, the Admiralty vessel put at the disposal of the kite-flying committee is no longer available, and it has been found impossible to bring the *Renown* (the boat from which the experiments are being conducted by Mr. W. H. Dines at Crinan) to Southport. The local committee has been offered the use of the *John Fell* by the Lancashire and Western Sea Fisheries Board for three days (Monday, Tuesday, and Wednesday, September 14, 15, and 16), but it is feared that the deck space will be insufficient for the proper conducting of the experiments. It is, therefore, possible that Mr. Dines will merely exhibit the apparatus at Southport, though every endeavour will be made to make use of the boat.

Prof. Pernter, of Vienna, has had forwarded to Southport one of the cannons used on the Continent for firing on clouds so as to arrest hailstorms. Test experiments in horizontal firing of vortex rings will be carried out on the Southport shore by permission of the Corporation.

A lecture has been arranged for Wednesday night, September 16, on "Garden Cities," by Mr. Ebenezer Howard, the founder of the Garden Cities Association, following an excursion on the same day to Port Sunlight, Cheshire, the model village erected by Messrs. Lever Brothers.

The local loan exhibition which is situated in the corridor near the reception room is in the hands of a small committee drawn from the Southport Literary and Philosophical Society, Society of Natural Science, and Photographic Society, and comprises local botanical and geological exhibits, photographs and drawings illustrating the antiquities of the district, and various exhibits of general scientific interest. The canoe which was dug out of the bed of Martin Mere in 1899 is being exhibited during the time of the meeting in the lecture room of Section H (Anthropology) in the Town Hall. The canoe is seventeen feet long and four feet wide.

The reception and writing rooms in the Art Gallery are rendered specially attractive by the presence on the walls of a portion of the Southport Corporation permanent collection of pictures.

The Mayor of Southport (Mr. T. T. L. Scarisbrick) is extending an almost lavish hospitality at his residence, Greaves Hall, Banks, and the local committee and the Southport Corporation are doing their utmost to make the meeting a memorable one so far as social entertainment is concerned. The Mayor has invited members of the Association to attend Emmanuel Church on Sunday morning, when the preacher will be the Bishop of Ripon. Other special preachers in Southport the same day include the Bishop of Liverpool, the Dean of Peterborough, the Rev. J. D. Bevan, the Rev. A. L. Cortie, S.J., the Rev. T. J. Walshe, the Rev. J. H. Moulton and the Rev. Frank Ballard (Wesleyan), the Rev. Dr. John Hunter (Congregational), the Rev. Dr. S. R. Macphail, Moderator of the Presbyterian Church of England, and the Rev. R. A. Armstrong (Unitarian).

In connection with the Mayor's and the committee's receptions to-night and on Tuesday next, a portion of the municipal gardens in front of the Cambridge Hall will be enclosed. These gardens are illuminated by electricity at night, more than 4000 glow-lamps being installed among the foliage of the trees. The installation is quite unique in this country. Special fittings had to be designed, as, being an outdoor installation, the electrical conditions are very severe. More than sixteen miles of underground and overhead cable are used.

The Mayor's dinner at Greaves Hall on Wednesday, September 16, promises to be a very brilliant function, and the lecture by Prof. Forsyth before the Literary and Philosophical Society on the following night on "Universities" will be largely attended by members of the British Association, a large number of whom have accepted the invitation to be present.

INAUGURAL ADDRESS BY SIR NORMAN LOCKYER, K.C.B., LL.D., F.R.S., CORRESPONDANT DE L'INSTITUT DE FRANCE, PRESIDENT OF THE ASSOCIATION.

The Influence of Brain-power on History.

MY first duty to-night is a sad one. I have to refer to a great loss which this Nation and this Association have sustained. By the death of the great Englishman and great statesman who has just passed away, we members of the British Association are deprived of one of the most illustrious of our confrères. We have to mourn the loss of an enthusiastic student of science who conferred honour on our body by becoming its President. We recognise that as Prime Minister he was mindful of the interests of science, and that to him we owe a more general recognition on the part of the State of the value to the nation of the work of scientific men. On all these grounds you will join in the expression of respectful sympathy with Lord Salisbury's family in their great personal loss which your council has embodied this morning in a resolution of condolence.

Last year, when this friend of science ceased to be Prime Minister, he was succeeded by another statesman who also has given many proofs of his devotion to philosophical studies, and has shown in many utterances that he has a clear understanding of the real place of science in modern civilisation. We then have good grounds for hoping that the improvement in the position of science in this country which we owe to the one will also be the care of his successor, who has honoured the Association by accepting the unanimous nomination of your council to be your President next year, an acceptance which adds a new lustre to this chair.

On this we may congratulate ourselves all the more because I think, although it is not generally recognised, that the century into which we have now well entered may be more momentous than any which has preceded it, and that the present history of the world is being so largely moulded by the influence of brain-power, which in these modern days has to do with natural as well as human forces and laws, that statesmen and politicians will have in the future to pay more regard to education and science, as empire-builders and empire-guarders, than they have paid in the past.

The nineteenth century will ever be known as the one in which the influences of science were first fully realised in civilised communities; the scientific progress was so gigantic that it seems rash to predict that any of its successors can be more important in the life of any nation.

Disraeli, in 1873, referring to the progress up to that year, spoke as follows:—"How much has happened in these fifty years—a period more remarkable than any, I will venture to say, in the annals of mankind. I am not thinking of the rise and fall of Empires, the change of dynasties, the establishment of Governments. I am thinking of those revolutions of science which have had much more effect than any political causes, which have changed the position and prospects of mankind more than all the conquests and all the codes and all the legislators that ever lived."[1]

The progress of science, indeed, brings in many considerations which are momentous in relation to the life of any limited community—any one nation. One of these considerations to which attention is now being greatly drawn is that a relative decline in national wealth derived from industries must follow a relative neglect of scientific education.

It was the late Prince Consort who first emphasised this when he came here fresh from the University of Bonn. Hence the "Prince Consort's Committee," which led to the foundation of the College of Chemistry and afterwards of the Science and Art Department. From that time to this the warnings of our men of science have become louder and more urgent in each succeeding year. But this is not all; the commercial output of one country in one century as compared with another is not alone in question; the acquirement of the scientific spirit and a knowledge and utilisation of the forces of Nature are very much further reaching in their effects on the progress and decline of nations than is generally imagined.

Britain in the middle of the last century was certainly the country which gained most by the advent of science, for she was then in full possession of those material gifts of Nature, coal and iron, the combined winning and utilisation of which, in the production of machinery and in other ways, soon made her the richest country in the world, the seat and throne of invention and manufacture, as Mr. Carnegie has called her. Being the great producers and exporters of all kinds of manufactured goods, we became eventually, with our iron ships, the great carriers, and hence the supremacy of our mercantile marine and our present command of the sea.

[1] NATURE, November 27, 1873, vol. ix. p. 71.

The most fundamental change wrought by the early applications of science was in relation to producing and carrying power. With the winning of mineral wealth and the production of machinery in other countries, and cheap and rapid transit between nations, our superiority as depending upon our first use of vast material resources was reduced. Science, which is above all things cosmopolitan—planetary, not national—internationalises such resources at once. In every market of the world

> "things of beauty, things of use,
> Which one fair planet can produce,
> Brought from under every star,"

were soon to be found.

Hence the first great effect of the general progress of science was relatively to diminish the initial supremacy of Britain due to the first use of *material* resources, which indeed was the real source of our national wealth and place among the nations.

The unfortunate thing was that, while the foundations of our superiority depending upon our *material resources* were being thus sapped by a cause *which was beyond our control*, our statesmen and our universities were blind leaders of the blind, and our other asset, our mental resources, which was within our control, was culpably neglected.

So little did the bulk of our statesmen know of the part science was playing in the modern world and of the real basis of the nation's activities, that they imagined political and fiscal problems to be the only matters of importance. Nor, indeed, are we very much better off to-day. In the important discussions recently raised by Mr. Chamberlain, next to nothing has been said of the effect of the progress of science on prices. The whole course of the modern world is attributed to the presence or absence of taxes on certain commodities in certain countries. The fact that the great fall in the price of food-stuffs in England did not come till some thirty or forty years after the removal of the corn duty between 1847 and 1849 gives them no pause; for them new inventions, railways and steamships are negligible quantities; the vast increase in the world's wealth in free trade and protected countries alike comes merely according to them in response to some *political* shibboleth.

We now know, from what has occurred in other States, that if our Ministers had been more wise and our universities more numerous and efficient, our *mental resources* would have been developed by improvements in educational method, by the introduction of science into schools, and, more important than all the rest, by the teaching of science by experiment, observation and research, and not from books. It is because this was not done that we have fallen behind other nations in properly applying science to industry, so that our applications of science to industry are relatively less important than they were. But this is by no means all; we have lacked the strengthening of the national life produced by fostering the scientific spirit among all classes, and along all lines of the nation's activity; many of the responsible authorities know little and care less about science; we have not learned that it is the duty of a State to organise its forces as carefully for peace as for war; that universities and other teaching centres are as important as battleships or big battalions; are, in fact, essential parts of a modern State's machinery, and as such to be equally aided and as efficiently organised to secure its future well being.

Now the objects of the British Association as laid down by its founders seventy-two years ago are "To give a stronger impulse and a more systematic direction to scientific inquiry—to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers—to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress."

In the main, my predecessors in this chair, to which you have done me the honour to call me, have dealt, and with great benefit to science, with the objects first named.

But at a critical time like the present I find it imperative to depart from the course so generally followed by my predecessors and to deal with the last object named, for unless by some means or other we "obtain a more general attention to the objects of science and a removal of any disadvantages of a

public kind which impede its progress," we shall suffer in competition with other communities in which science is more generally utilised for the purposes of the national life.

The Struggle for Existence in Modern Communities.

Some years ago, in discussing the relations of scientific instruction to our industries, Huxley pointed out that we were in presence of a new "struggle for existence," a struggle which, once commenced, must go on until only the fittest survives.

It is a struggle between organised species—nations—not between individuals or any class of individuals. It is, moreover, a struggle in which science and brains take the place of swords and sinews, on which depended the result of those conflicts which, up to the present, have determined the history and fate of nations. The school, the university, the laboratory and the workshop are the battlefields of this new warfare.

But it is evident that if this, or anything like it, be true, our industries cannot be involved alone; the scientific spirit, brain-power, must not be limited to the workshop if other nations utilise it in all branches of their administration and executive.

It is a question of an important change of front. It is a question of finding a new basis of stability for the Empire in face of new conditions. I am certain that those familiar with the present state of things will acknowledge that the Prince of Wales's call, "Wake up," applies quite as much to the members of the Government as it does to the leaders of industry.

What is wanted is a complete organisation of the resources of the nation, so as to enable it best to face all the new problems which the progress of science, combined with the ebb and flow of population and other factors in international competition, are ever bringing before us. Every Minister, every public department, is involved, and this being so, it is the duty of the whole nation—King, Lords, and Commons—to do what is necessary to place our scientific institutions on a proper footing in order to enable us to "face the music" whatever the future may bring. The idea that science is useful only to our industries comes from want of thought. If anyone is under the impression that Britain is only suffering at present from the want of the scientific spirit among our industrial classes, and that those employed in the State service possess adequate brain-power and grip of the conditions of the modern world into which science so largely enters, let him read the report of the Royal Commission on the War in South Africa. There he will see how the whole "system" employed was, in Sir Henry Brackenbury's words applied to a part of it, "*unsuited to the requirements of an Army which is maintained to enable us to make war.*" Let him read also, in the address of the president of the Society of Chemical Industry what drastic steps had to be taken by Chambers of Commerce and "a quarter of a million of working men" to get the Patent Law Amendment Act into proper shape, in spite of all the advisers and officials of the Board of Trade. Very few people realise the immense number of scientific problems the solution of which is required for the State service. The nation itself is a gigantic workshop, and the more our rulers and legislators, administrators and executive officers possess the scientific spirit, the more the rule of thumb is replaced in the State service by scientific methods, the more able shall we be, thus armed at all points, to compete successfully with other countries along all lines of national as well as of commercial activity.

It is obvious that the power of a nation for war, in men and arms and ships, is one thing; its power in the peace struggles to which I have referred is another; in the latter, the source and standard of national efficiency are entirely changed. To meet war conditions, there must be equality or superiority in battle-ships and army corps. To meet the new peace conditions, there must be equality or superiority in universities, scientific organisation and everything which conduces to greater brain power.

Our Industries are suffering in the Present International Competition.

The present condition of the nation, so far as its industries are concerned, is as well known, not only to the Prime Minister, but to other political leaders in and out of the Cabinet, as it is to you and to me. Let me refer to two speeches delivered by Lord Rosebery and Mr. Chamberlain on two successive days in January, 1901.

Lord Rosebery spoke as follows:—

"... The war I regard with apprehension is the war of trade which is unmistakably upon us. ... When I look round me I cannot blind my eyes to the fact that so far as we can predict anything of the twentieth century on which we have now entered, it is that it will be one of acutest international conflict in point of trade. We were the first nation of the modern world to discover that trade was an absolute necessity. For that we were nicknamed a nation of shopkeepers; but now every nation wishes to be a nation of shopkeepers too, and I am bound to say that when we look at the character of some of these nations, and when we look at the intelligence of their preparations, we may well feel that it behoves us not to fear, but to gird up our loins in preparation for what is before us."

Mr. Chamberlain's views were stated in the following words:—

"I do not think it is necessary for me to say anything as to the urgency and necessity of scientific training. ... It is not too much to say that the existence of this country, as the great commercial nation, depends upon it. ... It depends very much upon what we are doing now, at the beginning of the twentieth century, whether at its end we shall continue to maintain our supremacy or even equality with our great commercial and manufacturing rivals."

All this refers to our industries. We are suffering because trade no longer follows the flag as in the old days, but because trade follows the brains, and our manufacturers are too apt to be careless in securing them. In one chemical establishment in Germany, 400 doctors of science, the best the universities there can turn out, have been employed at different times in late years. In the United States the most successful students in the higher teaching centres are snapped up the moment they have finished their course of training, and put into charge of large concerns, so that the idea has got abroad that youth is the password of success in American industry. It has been forgotten that the latest product of the highest scientific education must necessarily be young, and that it is the training and not the age which determines his employment. In Britain, on the other hand, apprentices who can pay high premiums are too often preferred to those who are well educated, and the old rule-of-thumb processes are preferred to new developments—a conservatism too often depending upon the master's own want of knowledge.

I should not be doing my duty if I did not point out that the defeat of our industries one after another, concerning which both Lord Rosebery and Mr. Chamberlain express their anxiety, is by no means the only thing we have to consider. The matter is not one which concerns our industrial classes only, for knowledge must be pursued for its own sake, and since the full life of a nation with a constantly increasing complexity, not only of industrial, but of high national aims, depends upon the universal presence of the scientific spirit—in other words, brain-power—our whole national life is involved.

The Necessity for a Body dealing with the Organisation of Science.

The present awakening in relation to the nation's real needs is largely due to the warnings of men of science. But Mr. Balfour's terrible Manchester picture of our present educational condition[1] shows that the warning which has been going on now for more than fifty years has not been forcible enough; but if my contention that other reorganisations besides that of our education are needed is well founded, and if men of science are to act the part of good citizens in taking their share in endeavouring to bring about a better state of things, the question arises, has the neglect of their warnings so far been due to the way in which these have been given?

Lord Rosebery, in the address to a Chamber of Commerce from which I have already quoted, expressed his opinion that such bodies do not exercise so much influence as might be expected of them. But if commercial men do not use all the power their organisation provides, do they not by having built up such an organisation put us students of science to shame, who are still the most disorganised members of the community?

Here, in my opinion, we have the real reason why the scientific needs of the nation fail to command the attention either of the public or of successive Governments. At present, appeals on

[1] "The existing educational system of this country is chaotic, is ineffectual, is utterly behind the age, makes us the laughing-stock of every advanced nation in Europe and America, puts us behind, not only our American cousins, but the German and the Frenchman and the Italian."—*Times*, October 15, 1902.

this or on that behalf are the appeals of individuals; science has no collective voice on the larger national questions; there is no organised body which formulates her demands.

During many years it has been part of my duty to consider such matters, and I have been driven to the conclusion that our great crying need is to bring about an organisation of men of science and all interested in science, similar to those which prove so effective in other branches of human activity. For the last few years I have dreamt of a Chamber, Guild, League, call it what you will, with a wide and large membership, which should give us what, in my opinion, is so urgently needed. Quite recently I sketched out such an organisation, but what was my astonishment to find that I had been forestalled, and by the founders of the British Association!

The British Association such a Body.

At the commencement of this address I pointed out that one of the objects of the Association, as stated by its founders, was "to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress."

Everyone connected with the British Association from its beginning may be congratulated upon the magnificent way in which the other objects of the Association have been carried out, but as one familiar with the Association for the last forty years, I cannot but think that the object to which I have specially referred has been too much overshadowed by the work done in connection with the others.

A careful study of the early history of the Association leads me to the belief that the function I am now dwelling on was strongly in the minds of the founders; but be this as it may, let me point out how admirably the organisation is framed to enable men of science to influence public opinion and so to bring pressure to bear upon Governments which follow public opinion. (1) Unlike all the other chief metropolitan societies, its outlook is not limited to any branch or branches of science. (2) We have a wide and numerous fellowship, including both the leaders and the lovers of science, in which all branches of science are and always have been included with the utmost catholicity—a condition which renders strong committees possible on any subject. (3) An annual meeting at a time when people can pay attention to the deliberations, and when the newspapers can print reports. (4) The possibility of beating up recruits and establishing local committees in different localities, even in the King's dominions beyond the seas, since the place of meeting changes from year to year, and is not limited to these islands.

We not only, then, have a scientific parliament competent to deal with all matters, including those of national importance, relating to science, but machinery for influencing all new councils and committees dealing with local matters, the functions of which are daily becoming more important.

The machinery might consist of our corresponding societies. We already have affiliated to us seventy societies with a membership of 25,000; were this number increased so as to include every scientific society in the Empire, metropolitan and provincial, we might eventually hope for a membership of half a million.

I am glad to know that the Council is fully alive to the importance of giving a greater impetus to the work of the corresponding societies. During this year a committee was appointed to deal with the question; and later still, after this committee had reported, a conference was held between this committee and the corresponding societies committee to consider the suggestions made, some of which will be gathered from the following extract:—

"In view of the increasing importance of science to the nation at large, your committee desire to call the attention of the Council to the fact that in the corresponding societies the British Association has gathered in the various centres represented by these societies practically all the scientific activity of the provinces. The number of members and associates at present on the list of the corresponding societies approaches 25,000, and no organisation is in existence anywhere in the country better adapted than the British Association for stimulating, encouraging and coordinating all the work being carried on by the seventy societies at present enrolled. Your committee are of opinion that further encouragement should be given to these societies and their individual working members by every means within the power of the association; and with the object of keeping the corresponding societies in more permanent touch with the Association they suggest that an official invitation on behalf of the Council be addressed to the societies through the corresponding societies committee asking them to appoint standing British Association sub-committees, to be elected by themselves with the object of dealing with all those subjects of investigation common to their societies and to the British Association committees, and to look after the general interests of science and scientific education throughout the provinces and provincial centres. . . .

"Your committee desire to lay special emphasis on the necessity for the extension of the scientific activity of the corresponding societies and the expert knowledge of many of their members in the direction of scientific education. They are of opinion that immense benefit would accrue to the country if the corresponding societies would keep this requirement especially in view with the object of securing adequate representation for scientific education on the Education Committees now being appointed under the new Act. The educational section of the Association having been but recently added, the corresponding societies have as yet not had much opportunity for taking part in this branch of the Association's work; and in view of the reorganisation in education now going on all over the country your committee are of opinion that no more opportune time is likely to occur for the influence of scientific organisations to make itself felt as a real factor in national education. . . ."

I believe that if these suggestions or anything like them—for some better way may be found on inquiry—are accepted, great good to science throughout the Empire will come. Rest assured that sooner or later such a guild will be formed because it is needed. It is for you to say whether it shall be, or form part of, the British Association. We in this Empire certainly need to organise science as much as in Germany they find the need to organise a navy. The German Navy League, which has branches even in our Colonies, already has a membership of 630,000, and its income is nearly 20,000*l*. a year. A British Science League of 500,000 with a sixpenny subscription would give us 12,000*l*. a year, quite enough to begin with.

I for one believe that the British Association would be a vast gainer by such an expansion of one of its existing functions. Increased authority and prestige would follow its increased utility. The meetings would possess a new interest; there would be new subjects for reports; missionary work less needed than formerly would be replaced by efforts much more suited to the real wants of the time. This magnificent, strong and complicated organisation would become a living force, working throughout the year, instead of practically lying idle, useless and rusting for 51 weeks out of the 52 so far as its close association with its members is concerned.

If this suggestion in any way commends itself to you, then when you begin your work in your sections or general committee see to it that a body is appointed to inquire how the thing can be done. Remember that the British Association will be as much weakened by the creation of a new body to do the work I have shown to have been in the minds of its founders as I believe it will be strengthened by becoming completely effective in every one of the directions they indicated, and for which effectiveness we their successors are indeed responsible. The time is appropriate for such a reinforcement of one of the wings of our organisation, for we have recently included Education among our sections.

There is another matter I should like to see referred to the committee I have spoken of, if it please you to appoint it. The British Association, which as I have already pointed out is now the chief body in the Empire which deals with the totality of science, is, I believe, the only organisation of any consequence which is without a charter, and which has not His Majesty the King as patron.

The First Work of such an Organisation.

I suppose it is my duty after I have suggested the need of organisation to tell you my personal opinion as to the matters where we suffer most in consequence of our lack of organisation at the present time.

Our position as a nation, our success as merchants, are in peril chiefly—dealing with preventable causes—because of our lack of completely efficient universities, and our neglect of research. This research has a double end. A professor who is not learning cannot teach properly or arouse enthusiasm in his students; while a student of anything who is unfamiliar with research methods, and without that training which research

brings, will not be in the best position to apply his knowledge in after life. From neglect of research comes imperfect education and a small output of new applications and new knowledge to reinvigorate our industries. From imperfect education comes the unconcern touching scientific matters, and the too frequent absence of the scientific spirit, in the nation generally from the Court to the parish council.

I propose to deal as briefly as I can with each of these points.

Universities.

I have shown that so far as our industries are concerned, the cause of our failure has been run to earth; it is fully recognised that it arises from the insufficiency of our universities both in numbers and efficiency, so that not only our captains of industry, but those employed on the nation's work generally, do not secure a training similar to that afforded by other nations. No additional endowment of primary, secondary or technical instruction will mend matters. This is not merely the opinion of men of science; our great towns know it, our Ministers know it.

It is sufficient for me to quote Mr. Chamberlain:—

"It is not everyone who can, by any possibility, go forward into the higher spheres of education; but it is from those who do that we have to look for the men who, in the future, will carry high the flag of this country in commercial, scientific and economic competition with other nations. At the present moment, I believe there is nothing more important than to supply the deficiencies which separate us from those with whom we are in the closest competition. In Germany, in America, in our own colony of Canada and in Australia, the higher education of the people has more support from the Government, is carried further, than it is here in the old country; and the result is that in every profession, in every industry, you find the places taken by men and by women who have had a university education. And I would like to see the time in this country when no man should have a chance for any occupation of the better kind, either in our factories, our workshops or our counting-houses, who could not show proof that, in the course of his university career, he had deserved the position that was offered to him. What is it that makes a country? Of course you may say, and you would be quite right, 'The general qualities of the people, their resolution, their intelligence, their pertinacity, and many other good qualities.' Yes; but that is not all, and it is not the main creative feature of a great nation. The greatness of a nation is made by its greatest men. It is those we want to educate. It is to those who are able to go, it may be, from the very lowest steps in the ladder, to men who are able to devote their time to higher education, that we have to look to continue the position which we now occupy as, at all events, one of the greatest nations on the face of the earth. And, feeling as I do on these subjects, you will not be surprised if I say that I think the time is coming when Governments will give more attention to this matter, and perhaps find a little more money to forward its interests" (*Times*, November 6, 1902).

Our conception of a university has changed. University education is no longer regarded as the luxury of the rich which concerns only those who can afford to pay heavily for it. The Prime Minister in a recent speech, while properly pointing out that the collective effect of our public and secondary schools upon British character cannot be overrated, frankly acknowledged that the boys of seventeen or eighteen who have to be educated in them "do not care a farthing about the world they live in except in so far as it concerns the cricket-field or the football-field or the river." On this ground they are not to be taught science, and hence, when they proceed to the university, their curriculum is limited to subjects which were better taught before the modern world existed, or even Galileo was born. But the science which these young gentlemen neglect, with the full approval of their teachers, on their way through the school and the university to politics, the Civil Service, or the management of commercial concerns, is now one of the great necessities of a nation, and our universities must become as much the insurers of the future progress as battleships are the insurers of the present power of States. In other words, university competition between States is now as potent as competition in building battleships, and it is on this ground that our university conditions become of the highest national concern and therefore have to be referred to here, and all the more because our industries are not alone in question.

Why we have not more Universities.

Chief among the causes which have brought us to the terrible condition of inferiority as compared with other nations in which we find ourselves are our carelessness in the matter of education and our false notions of the limitations of State functions in relation to the conditions of modern civilisation.

Time was when the Navy was largely a matter of private and local effort. William the Conqueror gave privileges to the Cinque Ports on the condition that they furnished fifty-two ships when wanted. In the time of Edward III., of 730 sail engaged in the siege of Calais, 705 were "people's ships." All this has passed away; for our first line of defence we no longer depend on private and local effort.

Time was when not a penny was spent by the State on elementary education. Again, we no longer depend upon private and local effort. The Navy and primary education are now recognised as properly calling upon the public for the necessary financial support. But when we pass from primary to university education, instead of State endowment we find State neglect; we are in a region where it is nobody's business to see that anything is done.

We in Great Britain have thirteen universities competing with 134 State and privately endowed in the United States and twenty-two State endowed in Germany. I leave other countries out of consideration for lack of time, and I omit all reference to higher institutions for technical training, of which Germany alone possesses nine of university rank, because they are less important; they instruct rather than educate, and our want is education. The German State gives to one university more than the British Government allows to all the universities and university colleges in England, Ireland, Scotland, and Wales put together. These are the conditions which regulate the production of brain-power in the United States, Germany, and Britain respectively, and the excuse of the Government is that this is a matter for private effort. Do not our Ministers of State know that other civilised countries grant efficient State aid, and further, that private effort has provided in Great Britain less than 10 per cent. of the sum thus furnished in the United States in addition to State aid? Are they content that we should go under in the great struggle of the modern world because the Ministries of other States are wiser, and because the individual citizens of another country are more generous, than our own?

If we grant that there was some excuse for the State's neglect so long as the higher teaching dealt only with words, and books alone had to be provided (for the streets of London and Paris have been used as class rooms at a pinch), it must not be forgotten that during the last hundred years not only has knowledge been enormously increased, but things have replaced words, and fully equipped laboratories must take the place of books and class rooms if university training worthy of the name is to be provided. There is much more difference in size and kind between an old and new university than there is between the old caravel and a modern battleship, and the endowments must follow suit.

What are the facts relating to private endowment in this country? In spite of the munificence displayed by a small number of individuals in some localities, the truth must be spoken. In depending in our country upon this form of endowment, we are trusting to a broken reed. If we take the twelve English university colleges, the forerunners of universities unless we are to perish from lack of knowledge, we find that private effort during sixty years has found less than 4,000,000*l.*, that is, 2,000,000*l.* for buildings and 40,000*l.* a year income. This gives us an average of 166,000*l.* for buildings and 3300*l.* for yearly income.

What is the scale of private effort we have to compete with in regard to the American universities?

In the United States, during the last few years, universities and colleges have received more than 40,000,000*l.* from this source alone; private effort supplied nearly 7,000,000*l.* in the years 1898–1900.

Next consider the amount of State aid to universities afforded in Germany. The buildings of the new University of Strassburg have already cost nearly a million; that is, about as much as has yet been found by private effort for buildings in Manchester, Liverpool, Birmingham, Bristol, Newcastle and Sheffield. The Government annual endowment of the same German university is more than 49,000*l.*

This is what private endowment does for us in England, against State endowment in Germany.

But the State does really concede the principle; its present contribution to our Universities and colleges amounts to 155,600*l.* a year; no capital sum, however, is taken for buildings. The State endowment of the University of Berlin in 1891–2 amounted to 168,777*l.*

When, then, we consider the large endowments of university education both in the United States and Germany, it is obvious that State aid only can make any valid competition possible with either. The more we study the facts, the more statistics are gone into, the more do we find that we, to a large extent, lack both of the sources of endowment upon one or other or both of which other nations depend. We are between two stools, and the prospect is hopeless without some drastic changes. And first among these, if we intend to get out of the present slough of despond, must be the giving up of the idea of relying upon private effort.

That we lose most where the State does least is known to Mr. Chamberlain, for in his speech, to which I have referred, on the University of Birmingham, he said:—"As the importance of the aim we are pursuing becomes more and more impressed upon the minds of the people, we may find that we shall be more generously treated by the State."

Later still, on the occasion of a visit to University College School. Mr. Chamberlain spoke as follows:—

"When we are spending, as we are, many millions—I think it is 13,000,000*l.*—a year on primary education, it certainly seems as if we might add a little more, even a few tens of thousands, to what we give to University and secondary education" (*Times*, November 6, 1902).

To compete on equal grounds with other nations we must have more universities. But this is not all—we want a far better endowment of all the existing ones, not forgetting better opportunities for research on the part of both professors and students. Another crying need is that of more professors and better pay. Another is the reduction of fees; they should be reduced to the level in those countries which are competing with us, to, say, one-fifth of their present rates, so as to enable more students in the secondary and technical schools to complete their education.

In all these ways, facilities would be afforded for providing the highest instruction to a much greater number of students. At present there are almost as many *professors and instructors* in the universities and colleges of the United States as there are *day students* in the universities and colleges of the United Kingdom.

Men of science, our leaders of industry, and the chiefs of our political parties all agree that our present want of higher education—in other words, properly equipped universities—is heavily handicapping us in the present race for commercial supremacy, because it provides a relatively inferior brain-power which is leading to a relatively reduced national income.

The facts show that in this country we cannot depend upon private effort to put matters right. How about local effort?

Anyone who studies the statistics of modern municipalities will see that it is impossible for them to raise rates for the building and upkeep of universities.

The buildings of the most modern university in Germany have cost a million. For upkeep the yearly sums found, chiefly by the State, for German universities of different grades, taking the incomes of seven out of the twenty-two universities as examples, are:—

		£
1st Class ...	Berlin	130,000
2nd Class ...	Bonn / Göttingen	56,000
3rd Class ...	Königsberg / Strassburg	48,000
4th Class ...	Heidelberg / Marburg	37,000

Thus if Leeds, which is to have a university, is content with the 4th class German standard, a rate must be levied of 7*d.* in the pound for yearly expenses, independent of all buildings. But the facts are that our towns are already at the breaking strain. During the last fifty years, in spite of enormous increases in rateable values, the rates have gone up from about 2*s.* to about 7*s.* in the pound for real *local* purposes. But no university can be a merely local institution.

How to get more Universities.

What, then, is to be done? Fortunately, we have a precedent admirably in point, the consideration of which may help us to answer this question.

I have pointed out that in old days our Navy was chiefly provided by local and private effort. Fortunately for us, those days have passed away; but some twenty years ago, in spite of a large expenditure, it began to be felt by those who knew, that in consequence of the increase of foreign navies, our sea-power was threatened, as now, in consequence of the increase of foreign universities, our brain-power is threatened.

The nation slowly woke up to find that its enormous commerce was no longer insured at sea, that in relation to foreign navies our own had been suffered to dwindle to such an extent that it was no longer capable of doing the duty which the nation expected of it even in times of peace. At first, this revelation was received with a shrug of incredulity, and the peace-at-any-price party denied that anything was needed; but a great teacher arose;[1] as the facts were inquired into the suspicion changed into an alarm; men of all parties saw that something must be done. Later, the nation was thoroughly aroused, and with an universal agreement the principle was laid down that, cost what it might to enforce our sea-power, our Navy must be made and maintained of a strength greater than those of any two possibly contending Powers. After establishing this principle, the next thing to do was to give effect to it. What did the nation do after full discussion and inquiry? A Bill was brought in in 1888, and a sum of 21,500,000*l.* was voted in order, during the next five years, to inaugurate a large ship-building programme, so that Britain and Britain's commerce might be guarded on the high seas in any event.

Since then we have spent 120,000,000*l.* on new ships, and this year we spend still more millions on still more new ships. If these prove insufficient to safeguard our sea-power, there is no doubt that the nation will increase them, and I have not heard that anybody has suggested an appeal to private effort.

How, then, do we stand with regard to universities, recognising them as the chief producers of brain-power and therefore the equivalents of battleships in relation to sea-power? Do their numbers come up to the standard established by the Admiralty principle to which I have referred? Let us attempt to get a rough-and-ready estimate of our educational position by counting universities as the Admiralty counts battleships. I say rough and ready because we have other helps to greater brain-power to consider besides universities, as the Admiralty has other ships to consider besides ironclads.

In the first place, let us inquire if they are equal in number to those of any two nations commercially competing with us.

In the United Kingdom, we had until quite recently thirteen.[2] Of these, one is only three years old as a teaching university and another is still merely an examining board.

In Germany there are twenty-two universities; in France, under recent legislation, fifteen; in Italy twenty-one. It is difficult to give the number in the United States, because it is clear, from the tables given in the Report of the Commissioner of Education, that some colleges are more important than some universities, and both give the degree of Ph.D. But of universities in title we have 134. Among these, there are forty-six with more than fifty professors and instructors, and thirteen with more than 150. I will take that figure.

Suppose we consider the United States and Germany, our chief commercial competitors, and apply the Admiralty principle. We should require, allowing for population, eight additional universities at the very lowest estimate.

We see, then, that instead of having universities equalling in number those of two of our chief competitors together, they are by no means equal to those of either of them singly.

After this statement of the facts, anyone who has belief in the importance of higher education will have no difficulty in understanding the origin of the present condition of British industry and its constant decline, first in one direction and then in another, since the tremendous efforts made in the United States and Germany began to take effect.

If, indeed, there be anything wrong about the comparison, the error can only arise from one of two sources; either the Admiralty is thoughtlessly and wastefully spending money, or there is no connection whatever between the higher intelligence and the prosperity of a nation. I have already

1 Captain Mahan, of the U.S. Navy, whose book, "On the Influence of Sea-power on History," has suggested the title of my address.

2 These are Oxford, Cambridge, Durham, Victoria, Wales, Birmingham, London, St. Andrews, Glasgow, Aberdeen, Edinburgh, Dublin, and Royal University.

referred to the views of Mr. Chamberlain and Lord Rosebery on this point; we know what Mr. Chamberlain has done at Birmingham; we know the strenuous efforts made by the commercial leaders of Manchester and Liverpool; we know, also, the opinion of men of science.

If while we spend so freely to maintain our sea-power our export of manufactured articles is relatively reduced because our competitors beat us in the markets of the world, what is the end of the vista thus opened up to us? A Navy growing stronger every year and requiring larger votes to guard our commerce and communications, and a vanishing quantity of commerce to guard—a reduced national income to meet an increasing taxation!

The pity is that our Government has considered sea-power alone; that while so completely guarding our commerce, it has given no thought to one of the main conditions on which its production and increase depend: a glance could have shown that other countries were building universities even faster than they were building battleships; were, in fact, considering brain-power first and sea-power afterwards.

Surely it is my duty as your President to point out the danger ahead if such ignoring of the true situation should be allowed to continue. May I express a hope that at last, in Mr. Chamberlain's words, "the time is coming when Governments will give more attention to this matter"?

What will they cost?

The comparison shows that we want eight new universities, some of which, of course, will be colleges promoted to university rank and fitted to carry on university work. Three of them are already named: Manchester, Liverpool, Leeds.

Let us take this number and deal with it on the battleship condition, although a modern university on American or German models will cost more to build than a battleship.

If our present university shortage be dealt with on battleship conditions, to correct it we should expend *at least* 8,000,000*l*. for new construction, and for the pay-sheet we should have to provide (8 × 50,000*l*.) 400,000*l*. yearly for personnel and up-keep, for it is of no use to build either ships or universities without manning them. Let us say, roughly, capitalising the yearly payment at 2½ per cent., 24,000,000*l*.

At this stage, it is important to inquire whether this sum, arrived at by analogy merely, has any relation to our real university needs.

I have spent a year in making inquiries, as full as I could make them, of friends conversant with the real present needs of each of the universities old and new, I have obtained statistics which would fill a volume, and personally I believe that this sum at least is required to bring our university system up to anything like the level which is insisted upon both in the United States and in Germany. Even Oxford, our oldest university, will still continue to be a mere bundle of colleges, unless three millions are provided to enable the university properly so-called to take her place among her sisters of the modern world; and Sir Oliver Lodge, the principal of our very youngest university, Birmingham, has shown in detail how five millions can be usefully and properly applied in that one locality, to utilise for the good of the nation the enthusiasm and scientific capacity which are only waiting for adequate opportunity of development.

How is this money to be raised? I reply without hesitation, *duplicate the Navy Bill of* 1888–9; do at once for brain-power what we so successfully did then for sea-power.

Let 24,000,000*l*. be set apart from one asset, our national wealth, to increase the other, brain-power. Let it be assigned and borrowed as it is wanted; there will be a capital sum for new buildings to be erected in the next five or ten years, the interest of the remainder to go towards increased annual endowments.

There need be no difficulty about allocating money to the various institutions. Let each university make up its mind as to which rank of the German universities it wishes to emulate. When this claim has been agreed to, the sums necessary to provide the buildings and teaching staff of that class of university should be granted without demur.

It is the case of battleships over again, and money need not be spent more freely in one case than in the other.

Let me at once say that this sum is not to be regarded as practically gone when spent, as in the case of a short-lived ironclad. *It is a loan* which will bear a high rate of interest. This is not my opinion merely; it is the opinion of those concerned in great industrial enterprises and fully alive to the origin and effects of the present condition of things.

I have been careful to point out that the statement that our industries are suffering from our relative neglect of science does not rest on my authority. But if this be true, then if our annual production is less by only two millions than it might have been, having two millions less to divide would be equivalent to our having forty or fifty millions less capital than we should have had if we had been more scientific.

Sir John Brunner, in a speech connected with the Liverpool School of Tropical Medicine, stated recently that if we as a nation were now to borrow ten millions of money in order to help science by putting up buildings and endowing professors, we should get the money back in the course of a generation a hundredfold. He added that there was no better investment for a business man than the encouragement of science, and that every penny he possessed had come from the application of science to commerce.

According to Sir Robert Giffen, the United Kingdom as a going concern was in 1901 worth 16,000,000,000*l*.

Were we to put aside 24,000,000*l*. for gradually organising, building and endowing new universities, and making the existing ones more efficient, we should still be worth 15,976,000,000*l*., a property well worth defending by all the means, and chief among these brain-power, we can command.

If it be held that this, or anything like it, is too great a price to pay for correcting past carelessness or stupidity, the reply is that the 120,000,000*l*. recently spent on the Navy, a sum five times greater, has been spent to correct a sleepy blunder, not one whit more inimical to the future welfare of our country than that which has brought about our present educational position. We had not sufficiently recognised what other nations had done in the way of ship building, just as until now we have not recognised what they have been doing in university building.

Further, I am told that the sum of 24,000,000*l*. is less than half the amount by which Germany is yearly enriched by having improved upon our chemical industries, owing to our lack of scientific training. Many other industries have been attacked in the same way since, but taking this one instance alone, if we had spent this money fifty years ago, when the Prince Consort first called attention to our backwardness, the nation would now be much richer than it is, and would have much less to fear from competition.

Suppose we were to set about putting our educational house in order, so as to secure a higher quality and greater quantity of brain-power, it would not be the first time in history that this has been done. Both Prussia after Jena and France after Sedan acted on the view:—

"When land is gone and money spent,
Then learning is most excellent."

After Jena, which left Prussia a "bleeding and lacerated mass," the King and his wise counsellors, among them men who had gained knowledge from Kant, determined, as they put it, "to supply the loss of territory by intellectual effort."

What did they do? In spite of universal poverty, three universities, to say nothing of observatories and other institutions, were at once founded, secondary education was developed, and in a few years the mental resources were so well looked after that Lord Palmerston defined the kingdom in question as "a country of damned professors."

After Sedan, a battle, as Moltke told us, "won by the schoolmaster," France made even more strenuous efforts. The old University of France, with its "academies" in various places, was replaced by fifteen independent universities, in all of which are faculties of letters, sciences, law and medicine.

The development of the University of Paris has been truly marvellous. In 1897–8, there were 12,000 students, and the cost was 200,000*l*. a year.

But even more wonderful than these examples is the "intellectual effort" made by Japan, not after a war, but to prepare for one.

The question is, shall we wait for a disaster and then imitate Prussia and France? or shall we follow Japan, and thoroughly prepare by "intellectual effort" for the industrial struggle which lies before us?

Such an effort seems to me to be the first thing any national or imperial scientific organisation should endeavour to bring about.

Research.

When dealing with our universities, I referred to the importance of research, as it is now generally acknowledged to be the most powerful engine of education that we possess. But education after all is but a means to the end which, from the national point of view, is the application of old and the production of new knowledge.

Its national importance apart from education is now so generally recognised that in all civilised nations except our own means of research are being daily more amply provided for all students after they have passed through their university career, and more than this, for all who can increase the country's renown or prosperity by the making of new knowledge upon which not only commercial progress, but all intellectual advance must depend.

I am so anxious that my statement of our pressing, and indeed imperative, needs in this direction should not be considered as resting upon the possibly interested opinion of a student of science merely, that I must trouble you with still more quotations.

Listen to Mr. Balfour:—

"I do not believe that any man who looks round the equipment of our universities or medical schools, or other places of education, can honestly say in his heart that we have done enough to equip research with all the costly armoury which research must have in these modern days. We, the richest country in the world, lag behind Germany, France, Switzerland and Italy. Is it not disgraceful? Are we too poor or are we too stupid?"[1]

It is imagined by many who have given no thought to the matter that this research should be closely allied with some application of science being utilised at the time. Nothing could be further from the truth; nothing could be more unwise than such a limitation.

Surely all the laws of Nature will be ultimately of service, and therefore there is much more future help to be got from a study of the unknown and the unused than we can hope to obtain by continuing the study of that which is pretty well known and utilised already. It was a King of France, Louis XIV., who first commended the study of the *même inutile*. The history of modern science shows us more and more as the years roll on the necessity and advantage of such studies, and therefore the importance of properly endowing them, for the production of new knowledge is a costly and unremunerative pursuit.

Years ago we had Faraday apparently wasting his energies and time in playing with needles; electricity now fills the world. To-day men of science in all lands are studying the emanations of radium; no research could be more abstract; but who knows what advance in human thought may follow or what gigantic world-transforming superstructure may eventually be raised on the minute foundation they are laying?

If we so organise our teaching forces that we can use them at all stages from the gutter to the university to sift out for us potential Faradays—to utilise the mental products which otherwise would be wasted—it is only by enabling such men to continue their learning after their teaching is over that we shall be able to secure the greatest advantage which any educational system can afford.

It is now more than thirty years ago that my attention was specially drawn to this question of the endowment of research, first by conversations with M. Dumas, the permanent secretary of the Academy of Sciences, who honoured me by his friendship, and secondly by my association with Sir Benjamin Brodie and Dr. Appleton in their endeavours to call attention to the matter in this country. At that time a general scheme of endowment suggested by Dumas was being carried out by Duruy. This took the form of the "École spéciale des Hautes Études"; it was what our fellowship system was meant to be—an endowment of the research of post-graduate students in each seat of learning. The French effort did not begin then.

I may here tell, as it was told me by Dumas, the story of Léon Foucault, whose many discoveries shed a glory on France, and revived French industry in many directions.[2] In 1851, when Prince Napoleon was President of the Republic, he sent for Dumas and some of his colleagues and told them that during his stay in England, and afterwards in his study of the Great Exhibition of that year, he had found there a greater industrial development than in France, and more applications of science, adding that he wished to know how such a state of things could be at once remedied. The answer was that new applications depended upon new knowledge, and that therefore the most direct and immediate way was to find and encourage men who were likely by research in pure science to produce this new knowledge. The Prince President at once asked for names; that of Léon Foucault was the only one mentioned during the first interview.

Some time afterwards, to be exact at about 11 in the morning of December 2, Dumas's servant informed him that there was a gentleman in the hall named Foucault who wished to see him, and he added that he appeared to be very ill. When shown into the study, Foucault was too agitated to speak, and was blind with tears. His reply to Dumas's soothing questions was to take from his pockets two rolls of bank notes amounting to 200,000 francs and place them on the table. Finally, he was able to say that he had been with the Prince President since 8 o'clock that morning discussing the possible improvement of French science and industry, and that Napoleon had finally given him the money requesting him to do all in his power to aid the State. Foucault ended by saying that on realising the greatness of the task thus imposed upon him, his fears and feelings had got the better of him, for the responsibility seemed more than he could bear.[1]

The movement in England to which I have referred began in 1872, when a society for the organisation of academical study was formed in connection with the inquiry into the revenues of Oxford and Cambridge, and there was a famous meeting at the Freemasons' Tavern, Mark Pattison being in the chair. Brodie, Rolleston, Carpenter, Burdon-Sanderson, were among the speakers, and the first resolution carried was, "That to have a class of men whose lives are devoted to research is a national object." The movement died in consequence of the want of sympathy of the university authorities.[2]

In the year 1874 the subject was inquired into by the late Duke of Devonshire's Commission, and after taking much remarkable evidence, including that of Lord Salisbury, the Commission recommended to the Government that the then grant of 1000*l.* which was expended, by a committee appointed by the Royal Society, on instruments needed in researches carried on by private individuals should be increased, so that personal grants should be made. This recommendation was accepted and acted on; the grant was increased to 4000*l.*, and finally other societies were associated with the Royal Society in its administration. The committee, however, was timorous, possibly owing to the apathy of the universities and the general carelessness on such matters, and only one personal grant was made; the whole conception fell through.

Meantime, however, opinion has become more educated and alive to the extreme importance of research to the nation, and in 1891 a suggestion was made to the Royal Commission which administers the proceeds of the 1851 Exhibition that a sum of about 6000*l.* a year available for scholarships should be employed in encouraging post-graduate research throughout the whole Empire. As what happened is told in the Memoirs of Lord Playfair, it is not indiscreet in me to state that when I proposed this new form of the endowment of research, it would not have surprised me if the suggestion had been declined. It was carried through by Lord Playfair's enthusiastic support. This system has been at work ever since, and the good that has been done by it is now generally conceded.

It is a supreme satisfaction to me to know that in this present year of grace the national importance of the study of the *même inutile* is more generally recognised than it was during the times to which I have referred in my brief survey, and, indeed, we students are fortunate in having on our side in this matter two members of His Majesty's Government, who two years ago spoke with no uncertain sound upon this matter.

"Do we lack the imagination required to show what these apparently remote and abstract studies do for the happiness of mankind? We can appreciate that which obviously and directly ministers to human advancement and felicity, but seem,

1 NATURE, May 30, 1901

2 See *Proc. R.S.* vol. xvii., p. lxxxiii.

1 In order to show how history is written, what actually happened on a fateful morning may be compared with the account given by Kinglake:—"Prince Louis rode home and went in out of sight. Then for the most part he remained close shut up in the Elysée. There, in an inner room, still decked in red trousers, but with his back to the daylight, they say he sat bent over a fireplace for hours and hours together, resting his elbows on his knees, and burying his face in his hands" ("Crimean War," i. p. 245).

2 See NATURE, November and December, 1872.

somehow or another, to be deficient in that higher form of imagination, in that longer sight, which sees in studies which have no obvious, necessary, or immediate result the foundation of the knowledge which shall give far greater happiness to mankind than any immediate, material, industrial advancement can possibly do; and I fear, and greatly fear, that, lacking that imagination, we have allowed ourselves to lag in the glorious race run now by civilised countries in pursuit of knowledge, and we have permitted ourselves so far to too large an extent to depend upon others for those additions to our knowledge which surely we might have made for ourselves."—*Mr. Balfour*, NATURE, May 30, 1901.

"I would remind you that all history shows that progress—national progress of every kind—depends upon certain individuals rather than upon the mass. Whether you take religion, or literature, or political government, or art, or commerce, the new ideas, the great steps, have been made by individuals of superior quality and genius who have, as it were, dragged the mass of the nation up one step to a higher level. So it must be in regard to material progress. The position of the nation to-day is due to the efforts of men like Watt and Arkwright, or, in our own time, to the Armstrongs, the Whitworths, the Kelvins, and the Siemenses. These are the men who, by their discoveries, by their remarkable genius, have produced the ideas upon which others have acted and which have permeated the whole mass of the nation and affected the whole of its proceedings. Therefore what we have to do, and this is our special task and object, is to produce more of these great men."—*Mr. Chamberlain*, TIMES, January 18, 1901.

I finally come to the political importance of research. A country's research is as important in the long run as its battleships. The most eloquent teaching as to its national value we owe to Mr. Carnegie, for he has given the sum of 2,000,000*l.* to found a system of endowments, his chief purpose being, in his own words, "to secure if possible for the United States of America leadership in the domain of discovery and the utilisation of new forces for the benefit of man."

Here is a distinct challenge to Britain. Judging by experience in this country, in spite of the magnificent endowment of research by Mond and Lord Iveagh, the only sources of possible competition in the British interest is the State, which certainly could not put the 1/8000 part of the accumulated wealth of the country to better use, for without such help both our universities and our battleships will become of rapidly dwindling importance.

It is on this ground that I have included the importance of endowing research among the chief points to which I have been anxious to draw your attention.

The Need of a Scientific National Council.

In referring to the new struggle for existence among civilised communities, I pointed out that the solution of a large number of scientific problems is now daily required for the State service, and that in this and other ways the source and standard of national efficiency have been greatly changed.

Much evidence bearing upon the amount of scientific knowledge required for the proper administration of the public departments and the amount of scientific work done by and for the nation was brought before the Royal Commission on Science presided over by the late Duke of Devonshire now more than a quarter of a century ago.

The Commission unanimously recommended that the State should be aided by a scientific council in facing the new problems constantly arising.

But while the home Government has apparently made up its mind to neglect the advice so seriously given, it should be a source of gratification to us all to know that the application of the resources of modern science to the economic, industrial and agricultural development of India has for many years engaged the earnest attention of the Government of that country. The Famine Commissioners of 1878 laid much stress on the institution of scientific inquiry and experiment designed to lead to the gradual increase of the food-supply and to the greater stability of agricultural outturn, while the experience of recent years has indicated the increasing importance of the study of the economic products and mineral-bearing tracts.

Lord Curzon has recently ordered the heads of the various scientific departments to form a board, which shall meet twice annually, to begin with, to formulate a programme and to review past work. The board is also to act as an advisory committee to the Government,[1] providing among other matters for the proper coordination of all matters of scientific inquiry affecting India's welfare.

Lord Curzon is to be warmly congratulated upon the step he has taken, which is certain to bring benefit to our great dependency.

The importance of such a board is many times greater at home, with so many external as well as internal interests to look after, problems common to peace and war, problems requiring the help of the economic as well as of the physical sciences.

It may be asked, What is done in Germany, where science is fostered and utilised far more than here?

The answer is, there is such a council. I fancy very much like what our Privy Council once was. It consists of representatives of the Ministry, the universities, the industries, and agriculture. It is small, consisting of about a dozen members, consultative, and it reports direct to the Emperor. It does for industrial war what military and so-called defence councils do for national armaments: it considers everything relating to the use of brain-power in peace, from alterations in school regulations and the organisation of the universities, to railway rates and fiscal schemes, including the adjustment of duties. I am informed that what this council advises generally becomes law.

It should be pretty obvious that a nation so provided must have enormous chances in its favour. It is a question of drilled battalions against an undisciplined army, of the use of the scientific spirit as opposed to the hope of "muddling through."

Mr. Haldane has recently reminded us that "the weapons which science places in the hands of those who engage in great rivalries of commerce leave those who are without them, however brave, as badly off as were the dervishes of Omdurman against the Maxims of Lord Kitchener."

Without such a machinery as this, how can our Ministers and our rulers be kept completely informed on a thousand things of vital importance? Why should our position and requirements as an industrial and thinking nation receive less attention from the authorities than the headdress of the Guards? How, in the words of Lord Curzon,[2] can "the life and vigour of a nation be summed up before the world in the person of its sovereign" if the national organisation is so defective that it has no means of keeping the head of the State informed on things touching the most vital and lasting interests of the country? We seem to be still in the Palæolithic age in such matters, the chief difference being that the sword has replaced the flint implement.

Some may say that it is contrary to our habit to expect the Government to interest itself too much or to spend money on matters relating to peace; that war dangers are the only ones to be met or to be studied.

But this view leaves science and the progress of science out of the question. Every scientific advance is now, and will in the future be more and more, applied to war. It is no longer a question of an armed force with scientific corps, it is a question of an armed force scientific from top to bottom. Thank God the Navy has already found this out. Science will ultimately rule all the operations both of peace and war, and therefore the industrial and the fighting population must both have a large common ground of education. Already it is not looking too far ahead to see that in a perfect State there will be a double use of each citizen, a peace use and a war use, and the more science advances the more the old difference between the peaceful citizen and the man at arms will disappear; the barrack, if it still exists, and the workshop will be assimilated, the land unit, like the battleship, will become a school of applied science, self-contained, in which the officers will be the efficient teachers.

I do not think it is yet recognised how much the problem of national defence has thus become associated with that with which we are now chiefly concerned.

These, then, are some of the reasons which compel me to point out that a scientific council, which might be a scientific committee of the Privy Council, in dealing primarily with the national needs in times of peace, would be a source of strength to the nation.

To sum up, then. My earnest appeal to you is to gird up your loins and see to it that the science of the British Empire

[1] NATURE, September 4, 1902.
[2] *Times*, September 30, 1902.

New Series of Single-Pivot MOVING-COIL

GALVANOMETERS.

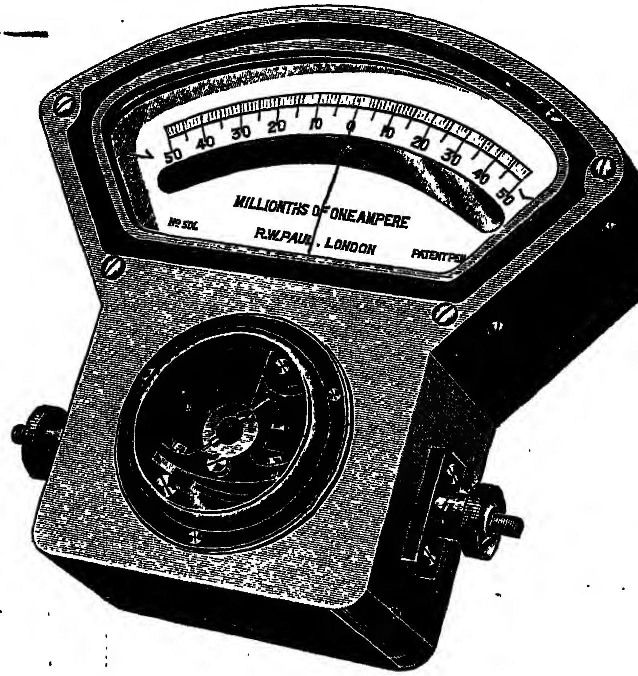
Three Patterns:

Portable, Sector and Vertical Scale.

SUPERSEDING
REFLECTING GALVANOMETERS
for many purposes.

**Reading in MICRO-AMPERES,
Milli-volts, Megohms,
Degrees Centigrade, &c.**

NO SUSPENSIONS OR DELICATE PARTS.



WRITE FOR PARTICULARS.

Robt. W. PAUL, 68 High Holborn, London, W.C.

AND AT NEWTON AVENUE WORKS, NEW SOUTHGATE, N.

THE

KAMMATOGRAPH.

A FILMLESS CINEMATOGRAPH.

500–600 Pictures on one Glass Plate.

The apparatus serves both to take and show these pictures life-size.

☞ NATURE says:—"The camera is very compact, and both as regards price and adaptability is within the reach of any photographer who wishes to secure pictures of rapidly changing scenes and moving objects."

SPECIALITIES MANUFACTURED BY US:—

OXYGEN AND ACETYLENE GENERATORS, PROJECTING LANTERNS, ARC LAMPS, RESISTANCES, AND OTHER SCIENTIFIC APPARATUS.

☞ *Catalogue post free to readers of* NATURE.

L. KAMM & CO., Scientific Engineers and Manufacturers,
27 POWELL STREET, LONDON, E.C.

X-RAY, &c. APPARATUS

OF THE HIGHEST QUALITY AND FINISH ONLY.

As supplied by us to H.M. Government and the leading Hospitals and Workers throughout the World.

We are the ACTUAL MANUFACTURERS, and Guarantee every Coil against breaking down.

LESSONS IN X-RAY, HIGH FREQUENCY, &c. WORK.

COX'S

"Pedestal" Pattern

HIGH FREQUENCY OUTFIT,

as used at the Middlesex and many other hospitals. With Drawer for Electrodes. Price £12. Special Insulated Handle with set of Electrodes for same, £4 10s.

N.B.—Our **INDUCTION COILS** and **APPARATUS** are not only less costly than other makers', but give results unexcelled by any of them.

☞ *Our Illustrated List with Instructions upon How to Work is out of print. A New and Enlarged Edition will be ready shortly, and applications are invited for its receipt free by post on publication.*

HARRY W. COX, LTD.,

FACTORY AND OFFICES:

9, 10 & 11 CURSITOR STREET, CHANCERY LANE, LONDON

R. CLAY AND SONS, LTD., BREAD ST. HILL, E.C., AND BUNGAY, SUFFOLK.

shall no longer remain unorganised. I have endeavoured to point out to you how the nation at present suffers from the absence of a powerful, continuous, reasoned expression of scientific opinion, urging in season and out of season that we shall be armed as other nations are with efficient universities and facilities for research to uphold the flag of Britain in the domain of learning and discovery, and what they alone can bring.

I have also endeavoured to show how, when this is done, the nation will still be less strong than it need be if there be not added to our many existing councils another, to secure that, even during peace, the benefits which a proper coordination of scientific effort in the nation's interest can bring shall not be neglected as they are at present.

Lest some of you may think that the scientific organisation which I trust you will determine to found would risk success in working on such large lines, let me remind you that in 1859, when the late Prince Consort occupied this chair, he referred to "impediments" to scientific progress, and said, "they are often such as can only be successfully dealt with by the powerful arm of the State or the long purse of the nation."

If the Prince Consort had lived to continue his advocacy of science, our position to-day would have been very different. His early death was as bad for Britain as the loss of a great campaign. If we cannot regain what we have lost, matters cannot mend.

I have done what I feel to be my duty in bringing the present condition of things before you. It is now your duty, if you agree with me, to see that it be put right. You can if you will.

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY CHARLES VERNON BOYS, F.R.S., PRESIDENT OF THE SECTION.

THE first duty of every occupant of this Chair is a sad one. Year by year the record grows of those who have devoted their lives to the development of mathematical and physical science, of those who have completed their work. The past year has added many names to the record—more, it seems, than its fair share. The names include some of the most brilliant and active of our race, of those to whom this Association is deeply indebted, and also of our fellow workmen in other countries whose loss is no less to be deplored.

Lord Salisbury's devotion to the empire, of which this is not the occasion to speak, left him but little time for those scientific pursuits in which he took so keen an interest. Once, however, as President of this Association, he showed our members that, unlike the majority of our statesmen, science was not to him a phantom. His Address at Oxford will remain in the memories of all who heard it. The eloquence, the humour, the satire, the subtlety provided an intellectual treat of the rarest kind.

Of Sir George Gabriel Stokes and his work it is not possible for me to speak. Any attempt on my part to appreciate or gauge the value of the work of such a giant would be an impertinence. This can only fitly be done by one of our leaders, and Lord Kelvin has paid a fitting tribute in the pages of NATURE. I can only record the fact that Stokes was for seven years Secretary, and twice President of this Section, and in 1869 was President of the Association.

Dr. Gladstone, for fifty-three years a member of this Association, was not only an unfailing attendant at our meetings, but an active member whose steady stream of original communications on subjects connecting physics and chemistry earned for him the designation of Creator of Physical Chemistry. His investigations on spectroscopy, refractivity and electrolytics are known to every student of physics. His researches upon early metallurgical history, while of less importance to the progress of science, are none the less interesting. An ardent apostle of education, he was for twenty-one years a member of the London School Board, and three years vice-chairman. Dr. Gladstone was the first President of the Physical Society. He has been President of the Chemical Society, and at the last meeting of the British Association at Southport—as also in 1872—he was President of the Chemical Section. So long ago, he said, in urging the importance of science as a factor in education, that the so-called educated classes were not only ignorant of science, but had not arrived at the knowledge of their own ignorance.

It is not possible to pass on without paying a tribute, in which all who knew Dr. Gladstone will share, to his character no less than to his genius.

Sir William Roberts-Austen was probably one of the most active members that this Association has known. Not only had he for many years made the subject of metals and alloys his own, but he worked for the Association in many ways. At three meetings have audiences been charmed by his fascinating and brilliant evening lectures, all relating to metals. He was President of the Chemical Section at the Cardiff meeting in 1891, and not only did he perform these duties, but he accepted the more laborious and more thankless task, for which his unfailing courtesy and tact so well fitted him, of acting as our General Secretary for four years. His labours in the important field of research which he tilled were appreciated by numerous technical societies and institutions of which he was an honorary member, or had been president or vice-president. Many branches of the public service had the advantage of his skill and experience, which received the official reward in 1899.

Dr. Common's skill as a designer and constructor of instruments was well known. His instinct or judgment in producing planes and figured concave mirrors of great dimensions was rare, for this is an art almost unknown in the laboratory. His generosity and his valuable advice have been appreciated by many besides myself.

Rev. H. W. Watson, Second Wrangler and Smith's Prizeman in 1850, was a Vice-President of the British Association in 1886. Mathematical physicists are familiar with the joint work of himself and Burbury on "Generalised Co-ordinates," and with his mathematical articles.

In Otto Hilger, the brother of the late Adam Hilger, who between them brought to this country German thoroughness and French skill in instrument manufacture, we have lost one of our first and most valuable constructors. Noted for the high class of all the optical work turned out by the firm, Otto Hilger was not afraid of attacking the problem of manufacturing the Michelson echelon grating. This little bundle of glass plates requires for its success perfection and precision commensurable only with the genius of the inventor. This Otto Hilger supplied.

Dean Farrar, a life member of the British Association, whose activity lay in another direction, showed his appreciation of the value of science in education by appointing the first science master at Marlborough when he became headmaster in the year 1870. As I was a boy at the school at that time, I can speak of the incredulity with which such an announcement was at first received and of the general feeling that such an action was akin to a joke. I was, however, by no means the only boy who hailed the news with delight. We devoured the feast of chemistry and physics put before us by Rodwell and the books which at once became available. Out of gratitude to the late Dean of Canterbury I recall this episode.

James Wimshurst, the inventor of the influence machine which has carried his name into every corner of the scientific world, was not a member of this Association, but he fostered and encouraged the scientific spirit in young men who, by good fortune, came to know him. I do not think I have heard anyone spoken of with such gratitude and appreciation as Wimshurst, by men who in their younger days were allowed the run of his well-equipped workshop.

James Glaisher, best known as a balloonist in the sixties, has died at the great age of ninety-three. The balloon ascent with Coxwell on September 5, 1862, when they attained the altitude of 37,000 feet, will long remain in the popular imagination, not on account simply of the great altitude, but by reason of the sensational account of their having been paralysed with cold, and of their being able to stop the ever-increasing ascent only by the presence of mind of Coxwell, who, with his limbs frozen, seized the valve rope with his teeth, and so let out the gas.

While this event remains in everyone's mind, the more prosaic work of Glaisher in astronomy, meteorology, and photography, when most of us were children, and many yet unborn, led to his being elected president of various learned societies.

He gave one of the evening lectures of the British Association in 1863, the subject being balloon ascents.

A. F. Osler, the inventor of the self-recording direction and pressure anemometer and rain gauge, whose active meteorological work was carried out in the first half of the last century, when he contributed papers to the British Association and the Literary and Philosophical Society of Birmingham, has died at the still greater age of ninety-five. He was Vice-President of the British Association in 1865.

Of other countries, America has lost Prof. J. Willard Gibbs, a mathematical physicist whose very learned and original contributions to the knowledge of the world on the thermodynamical properties of bodies, on vectors, the kinetic theory of gases, and other abstruse subjects, have received the highest recognition that the learned societies of this country can bestow. Prof. Harkness, the astronomer, and Prof. Rood, the skilled experimental physicist of Troy, have also maintained the high standard that we now look for in American science.

Germany has lost Prof. Deichmüller, Professor of Astronomy at Bonn, at an early age. Sweden has lost Prof. Bjerknes, whose hydrodynamical experiments showing attraction and repulsion were so much admired when he performed them at a meeting of the Physical Society some twenty-five years ago. Switzerland has lost Prof. C. Dufour, the astronomer; and Italy has lost Prof. Luigi Cremona, a foreign member of this Association, Principal of the Engineering School in Rome, whose contributions to pure geometry and to its applications have made him famous.

Of the events of the last year, one stands out beyond all others, not only for its intrinsic importance and revolutionary possibilities, but for the excitement that it has raised among the general public. The discovery by Prof. and Madame Curie of what seems to be the everlasting production of heat in easily measurable quantity by a minute amount of a radium compound is so amazing that, even now that many of us have had the opportunity of seeing with our own eyes the heated thermometer, we hardly are able to believe what we see. This, which can barely be distinguished from the discovery of perpetual motion, which it is an axiom of science to call impossible, has left every chemist and physicist in a state of bewilderment. Added to this, Sir William Crookes has devised an experiment, characteristic of him, if I may say so, in which a particle of radium keeps a screen bombarded for ever, so it seems, each collision producing a microscopic flash of light, the dancing and multitude of which forcibly compel the imagination to follow the reasoning faculties, and realise the existence of atomic tumult. Thanks to the industry and genius of J. J. Thomson, Rutherford and Soddy, Sir William and Lady Huggins, Dewar and Ramsay, and others in this country, besides Prof. and Madame Curie and a host of others abroad, this mystery is being attacked, and theories are being invented to account for the marvellous results of observation; but the theories themselves would a few years ago have seemed more wonderful and incredible than the facts, as we believe them to be, do to-day. An atom of radium can constantly produce an emanation, that is something like a gas, which escapes and carries with it wonderful properties; but the atom, the thing which cannot be divided, remains, and retains its weight. The emanation is truly wonderful. It is self-luminous, it is condensed by extreme cold and vaporises again; it can be watched as it oozes through stopcocks or hurries through tubes, but in amount it is so small that it has not yet been weighed. Sir William Ramsay has treated it with a chemical cruelty that would well-nigh have annihilated the most refractory or permanent known element; but this evanescent emanation comes out of the ordeal undimmed and undiminished.

Not content with manufacturing so remarkable a substance, the radium atom sends out three kinds of rays, one kind being much the same as Röntgen rays, but wholly different in ionising power, according to the experiments of Strutt. Each of these consists of particles which are shot out, but they have different penetrative power; they are differently deflected by magnets and also by electricity, and the quantity of electricity in relation to the weight is different, and yet the atom, the same atom, remains unchanged and unchangeable. Not only this, but radium or its emanations or its rays must gradually create other bodies different from radium, and thus, so we are told, one at least of those new gases which but yesterday were discovered has its origin.

Then, again, just as these gases have no chemical properties, so the radium which produces them in some respects behaves in a manner contrary to that of all proper chemicals. It does not lose its power of creating heat even at the extreme cold of liquid air, while at the greater degree of cold of liquid hydrogen its activity is found by Prof. Dewar to be actually greater.

Unlike old-fashioned chemicals which, when they are formed, have all their properties properly developed, radium and its salts take a month before they have acquired their full power (so Dewar tells us), and then, for anything we know to the contrary, proceed to manufacture heat emanations, three kinds of rays, electricity, and gases for ever. For ever; well, perhaps not for ever, but for so long a time that the loss of weight in a year, calculated, I suppose, rather than observed, is next to nothing. Prof. Rutherford believes that thorium or uranium, which act in the same kind of way, but with far less vigour, would last a million years before there was nothing left, or at least before they were worn out; while the radium, preferring a short life and a merry one, could not expect to exist for more than a few thousand years.

In this time one gramme of radium would evolve one thousand million heat units, sufficient, if converted into work, to raise five hundred tons a mile high; whereas a gramme of hydrogen, our best fuel, burned in oxygen, only yields thirty-four thousand heat-units, or one thirty-thousandth part of the output of radium. I believe that this is no exaggeration of what we are told and of what is believed to be experimentally proved with regard to radium; but if the half of it is true the term "the mystery of radium" is inadequate: the miracle of radium is the only expression that can be employed.

With all this mystery before us, which I must confess myself wholly unable to follow, I feel sure that members of the Association who are interested in the work of this Section will welcome the discussion, for which our secretaries have been able to arrange, and hear from the lips of Prof. Rutherford the conclusions to which his researches have at present brought him. No one is more fitted than Prof. Rutherford to open such a discussion, for no one has attacked the theoretical side with such originality and daring, or with such ingenuity of experiment.

As an example of the activity of mind and of research to which the activity of radium has given rise, I may mention the fact that the last number of the *Proceedings* of the Royal Society is wholly concerned with radium, there being four papers, all of the first importance, dealing with entirely different phenomena.

It is not my purpose to review these or the subject of radium generally; I am in no way fitted to do so. But I cannot well let the present opportunity pass of referring to another mystery of which a conspicuous example is now leaving us. I refer to the mystery of the comet and its tails. What is a comet? of what does its tail consist? Gravitational astronomy has told us for many years past that compared with the planets or their satellites a comet does not weigh anything. It weighs pounds or perhaps hundreds, thousands, or millions of tons; but in comparison with inconspicuous satellites it weighs nothing. Yet some of them as they approach the sun from remote regions begin to shoot out streamers which pour away as though repelled by the sun, not being left as a trail behind the comet, as is so often supposed. These streamers, ejected towards the sun, bend round and pour away at speeds which are enormous compared with that of the comet itself, thus producing the tail. Now these streams separate very often, and give rise to comets with two or three tails. Let me read one paragraph from "The History of Astronomy," by Miss Clerke:—

"The amount of tail curvature, he [Olbers] pointed out, depends in each case upon the proportion borne by the velocity of the ascending particles to that of the comet in its orbit; the swifter the outrush the straighter the approaching tail. But the velocity of the ascending particles varies with the energy of their repulsion by the sun, and this again, it may be presumed, by their quality. Thus multiple tails are developed when the same comet throws off, as it approaches perihelion, specifically distinct substances. The long straight ray which proceeded from the comet of 1807,

for example, was doubtless made up of particles subject to a much more vigorous solar repulsion than those formed into the shorter curved emanation issuing from it nearly in the same direction. In the comet of 1811 he calculated that the particles expelled from the head travelled to the remote extremity of the tail in eleven minutes, indicating by this enormous rapidity of movement (comparable to that of the transmission of light) the action of a force much more powerful than the opposing one of gravity. The not uncommon phenomena of multiple envelopes, on the other hand, he explained, are due to the varying amounts of repulsion exercised by the nucleus itself on the different kinds of matter developed from it."

It is impossible not to be struck by the similarity both of phenomenon described and of language used in this paragraph and in almost any of the papers on radium. I know this mere superficial similarity is worth very little, if anything; but for centuries the sky has shown us a phenomenon still not entirely understood, and the inability to remove all difficulty by the aid of radium or similar material is no reason for dismissing the idea of connection without further thought.

The comet's tail is still a mystery. Let me take the most recent explanation, which was set forth only three months ago in the *Astrophysical Journal* in the United States. Those admirable experimentalists Nichols and Hull have for some years been investigating the back pressure exerted by the action of light upon bodies on which it falls. In this they have followed the Russian physicist Lebedew, but in minuteness and delicacy of measurement, and in their successful elimination of disturbances, their results are unequalled. It is sufficient to say that, difficult and minute as the experiment is, their success is such that the discrepancy between the calculated force and that which they have found is under 1 per cent. Perhaps I may express some satisfaction that in this measurement use was made of the quartz fibre.

Having now definite and accurate confirmation of the existence of the force produced by the action of light, or rather radiation, Nichols and Hull proceed to examine the question as to how far such repulsion may be competent to overcome the gravitative attraction of the sun and drive away the matter which pours out from the comet. It is interesting to note here that Kepler put forward this very idea, and that Newton, the inventor of the corpuscular theory of light, looked upon the suggestion with some favour.

Coming now to this recent paper of Nichols and Hull, we find first the consideration of the relation of the attraction by gravitation, and the repulsion by light upon particles of different sizes and densities. Density has no influence on the action of light, while it is favourable to gravitation, and therefore unfavourable to tail formation. Size is favourable to both, but more to gravitation than to light, for if the diameter of a particle be doubled, one is increased eightfold and the other only four. So size favours gravitational attraction. Conversely, of course, smallness favours repulsion by light, which relatively should get greater and greater as the particles diminish in size. At last, then, a degree of smallness may be reached in which the repulsion by light will actually be equal to the attraction by gravitation, and such a particle would remain in space, its motion unaffected by our sun. Let the diminution of size continue, and then the repulsion will be in excess, and if the law were to continue it would with sufficient diminution become relatively as large as we please.

The law, however, does not continue. Schwarzschild has shown that when the particles are small enough, light does not act upon them in the same way. Owing to diffraction, the effect of light is unduly great for a certain very small size of particle, while it fails almost entirely when the particle is made much smaller. Thus it is that the indefinite increase in the repulsion by light as compared with the attraction by gravitation with diminution of size of particle is checked, and when, according to theory, with a particular density of particle, the light pressure is about twenty times as great as gravitational attraction, further diminution of size ceases to favour the action of light, and it begins to fall off again. The distance of the particle from the sun has no influence upon the relation between the two kinds of forces, for they rise and fall together. Nichols and Hull, therefore, while not denying that other causes may operate, believe that light pressure is adequate to account for the phenomena, and that where the material coming from the head or comet proper is of two or three kinds, whether of density or of size of particle, the separation of the two or three tails should naturally follow.

This theory presupposes that the nucleus of a comet will be able, owing to the evolution of gas under the sun's heat, to send out enormous quantities of dust, the finer and lighter the better, so long as it is not unduly small with respect to a wave-length of light. Such dust would account for any reflected solar light that the spectroscope may show, but it is not easy to see how the spectrum of hydrocarbons, of sodium, and of other metal, should be produced for lack of temperature. It is not easy to see why fortuitous dust should be graded of such sizes as to give well separated and defined tails; it is not easy to see how the dust could be produced in sufficient quantity to provide visible illumination to millions of millions of cubic miles of space through which it may be passing at ultra-planetary velocity, even though in looking through a million miles or so one grain of dust in a hundred miles might suffice to supply the light.

Other theories of the comet's tail require an electrified sun, the existence of which is explained by Arrhenius as being caused by the emission by the sun of negatively charged electrons which, picking up condensing gases as Aitken's dust picks up moisture from the atmosphere, are driven away by the light pressure. Arrhenius believes that these acting on the matter in the tail would give rise to the bright line spectra which have been observed. The result of all this escape of negative electricity is a positively charged sun, but what limits the charge in the sun it is as difficult to see, as it is, why the electrostatic attraction helped by gravitation does not ultimately stop the action. I may be displaying my ignorance, of which I am sufficiently sensible, but I am not aware of any evidence for the existence of the stream of electrified grains or drops imagined by Arrhenius.

Nichols and Hull, while calling to their aid the researches of Schwarzschild to give them a repulsive force some twenty times as great as gravitative attraction, do not seem to have given due weight to the extremely small range of size of particle for which this high effect is available. The maximum effect for any wave-length according to Schwarzschild is produced, when the size is such that a wave-length will just reach round it; that is, with ordinary light when the diameter is between one hundred thousandth and one hundred and fifty thousandth of an inch. If the diameter is two-and-a-half times the wave-length the action of light is only equal to gravity with a material of the density of water; or again, if it is reduced to one-eighth of a wave-length it again becomes equal, and in these two cases there is no resultant action. With either larger or smaller particles gravity rapidly gets the better of light, while the high advantage of light over gravity is confined to very narrow limits.

What the sifting process can be that will give rise to such a quantity of this microscopic dust we can hardly expect to be told, nor why even if the material should in some mysterious way be graded, the ungraded wave-lengths of the solar spectrum should allow of the marked separation in some instances of comets' tails.

One thing, however, they do assert, and that is that the light pressure can have no action on a gas, so that if what we see is considered to be gaseous the light pressure theory must be thrown over for some other.

I cannot leave this excursion of Nichols and Hull into a speculative domain of science without expressing my admiration of the experimental work which they have accomplished, and my appreciation of the ingenuity and daring with which they have attempted the hitherto unheard-of feat of making a comet.

While the theory just referred to may be the most recent it must not on that account be supposed to displace all that has gone before; the authors themselves do not suggest this; it is the last thing that would occur to them. They have referred to the researches of Bredechin that occupy so large a proportion of the annals of the Observatory of Moscow.

It is impossible to read even a tithe of these without feeling that the subject of comets and their tails is one which

Bredechin, by his amazing industry, has made his own property, and that any stranger casually passing by and taking a random shot should receive the severe penalty awarded to poachers in this country. Bredechin has dealt unmercifully —I do not say unjustly—with the author of at least one such random theory.

It is therefore with the greater diffidence and more urgent plea for forbearance that I venture to draw certain parallels and hazard certain suggestions which I admit freely have not reached a stage at which detailed comparisons with known comets are possible.

It does not seem possible now to contemplate the phenomena of the comet, of the divided tails, of their tenuity and transparency, of the pale luminosity, partly reflected solar light, partly light as from a glowing gas; of the gradual wearing out and disappearance of those comets which constantly pay visits to solar regions, with all the mysteries of radium now so much in evidence without tracing the features in which they resemble one another. By radium, of course, I mean any material with the remarkable radioactive properties that radium exhibits with such pre-eminent splendour, whether known in the laboratory or not.

How many physicists have been peering at comets through radium spectacles, or how many astronomers detect the sparkle of radium in the fairy tresses of their hirsute stars I know not. One writer, however, T. C. Chamberlin, so long ago as July, 1901, looked upon a connection between radio-active materials such as were then known and comets as at least worth considering. Chamberlin's paper in the *Astrophysical Journal* was mainly on the tidal disruption of gravitating bodies and the possible evolution of comets, nebulæ and meteorites, and he did not pursue this consideration in any detail; indeed, the enormous accumulation of new properties of radium was not then available.

Whatever may be imagined as to the constitution of a comet, difficulties still remain. All I suggest now is that the curious properties of radium and of similar bodies should be kept in mind. Radium at least supplies the means by which, if the increasing warmth or the tidal action of the sun should awaken its activity, Rutherford's α-rays should be shot out at the speed that he has measured of a thousand million inches a second, *i.e.* one-twelfth the velocity of light. These α-rays, according to Rutherford, consist of helium; they weigh each twice as much as a hydrogen atom, and so the same weight of comet matter that would make one of Nichols and Hull's best particles, *i.e.* one that would be just visible with a microscope, would be sufficient for about 400 millions of Rutherford's α-ray particles, an advantage surely where diffuseness seems so miraculous.

These particles, shot out at a velocity one-twelfth that of light, go so fast that, if they were to start horizontally on the surface of the earth, the gravitative attraction of the earth would curve their path to the infinitesimal extent of a curve with a radius of forty thousand million miles. Yet so great is the electric charge they carry that a visible curvature can be imposed upon them in a practicable electrostatic field.

Now imagine these transferred into space at a distance from the sun, for instance, equal to that of Venus. Gravity there due to the sun is only one-thousandth of what it is here, so gravity there would be, to the same extent, less able to impose visible curvature on their paths. But their electric charges are still available, and unless I have made an arithmetical blunder of a considerable order, it would require no very heavy electrification of the sun to bend these rays round in a curve with a radius of 1000 miles. An electrostatic field of under two ten-thousandths of a unit should be sufficient, a field which would be produced if the sun were only charged with a surface density of one electrostatic unit on every three square centimetres.

Whether these figures are correct or not—and I know the risk of getting just thirty thousand million times too large or too small a result—does not much matter. An electrified sun, which after all others besides Arrhenius have postulated, would be sufficient to turn the rays and send them away at rapidly increasing speed so as to form the tail. The speed would in a short time reach the velocity of light if it were not for the change in properties of matter which supervenes when any such velocity is nearly reached. Thus, according to the ratio of charge to mass, particles such as Rutherford's α-rays would be sent away each with its limiting velocity, giving rise to streaks more or less well defined, and double, triple, or multiple according to the number of kinds of ray which the various radio-active materials were able to generate.

Not only should streaks pointing away from the sun be formed, but any negatively charged rays such as radium is said to give out should form a tail directed towards the sun. Perhaps this might be expected to be general, but while not common one was described by Hind in the comet of 1823–24, and three or four more have been observed.

The head or coma would be the envelope of all the independent orbits, leaving the nucleus in all directions—orbits which while their velocities are still of the Rutherford order would be hyperbolas convex to the sun.

If this should not appear to be absolute nonsense it would seem as if another difficulty should become less than it has been. I refer to the visibility, luminosity, and spectral character.

Lodge, as an interpreter of Larmor, tells us that an electrified ion subject to acceleration, whether transverse or in the line of motion, radiates energy. The streamers from the nucleus subject to the greatest acceleration may be bright almost as the nucleus itself; then, as they have become dissipated into regions where far less acceleration becomes possible, the radiation falls off and the tail is lost in space.

The observations made last month by Sir William and Lady Huggins of the spectrum given by a piece of radium in the air may have some bearing upon the luminosity of the comet. It is possible that the internal motions set up by the separate parts, each pursuing its individual orbit, may produce collisions numerous and violent enough to account for all the light that is seen, and for temperature sufficient to bring out the spectral lines that have been identified. Whether this is so or not, radio-active bodies and their emanations can produce light independently of such action; and now these observers have found that in the case of radium in air this light gives the spectrum, line by line, of nitrogen. Is it possible that the enveloping nitrogen has had its atoms so harried by the activity of the radium as to give a response hitherto only awakened by electric discharge? The ability to obtain such a response opens up a new possible interpretation of these spectra, which hitherto have been assumed, with our laboratory experience only to guide us, to have required for their production temperature above a red heat. If further observation should confirm this, the hydrogen, the hydrocarbon, and possibly even the sodium or iron spectrum that has been observed, may have come from cold atoms; and it is not even quite beyond the limits of imagination to picture, not from the comet matter itself, but from loose residual and highly attenuated matter through which the comet is passing.

There is one other feature of this remarkable observation of equal interest. The lines of the spectrum were not exactly in their proper place, but were all shifted towards the red end of the spectrum about twice the distance between the D lines. If only one or two lines had been so observed a different origin might well have been suspected; but when the whole series are faithfully reproduced it is reasonable to look upon the spectrum as modified to that extent as though the works of the nitrogen atom had not only been set in movement, but had been loaded with the radium emanation.

Before dismissing these random speculations on the possible connection between radio-activity and comets I would ask your leave to refer once more to Bredechin's conclusions. He has found that it is merely necessary to postulate three kinds of matter, issuing from the nucleus with three initial velocities, and subject to repulsion from the sun with three sets of forces of repulsion—*i.e.* as compared with ordinary gravitative attraction—for the whole of the phenomena of all sorts of comets to be very completely accounted for. His highest initial velocity is only about five miles a second, and his lowest about a quarter of a mile a second. His highest repulsion, after deducting gravitative attraction, is only eleven times gravity, and his lowest only a fifth of gravity. If, then, with such velocities and forces the phenomena can be exactly accounted for, it would seem futile to consider the possibility of initial velocities from 4000 to 80,000 times as great and effective repulsions of a corresponding order being able to produce effects with anything in common. This is not necessarily the case, for with the comparatively slow separation of the atoms of Bredechin's matter from the nucleus, each one describing its own hyperbola convex

to the sun, the tail at any moment represents the then position of any number of atoms which left the nucleus for some distance back, whereas with the enormous velocities and effective forces now discussed the comet moves so slowly in comparison that the tail would practically represent the path at the time.

It has taken me far longer to throw out this not very luminous ray than I had expected or than it is worth. I fear that it is a sort of ray in which the ratio of its dead weight to its vitalising charge is too small to enable it to penetrate the lightest screen of examination.

These are the days of rays, and now before we have quite become familiar with the rays of radio-active bodies Blondlot has presented us with N rays, which issuing from the mantle of an incandescent gas burner penetrate wood or aluminium, and then increase the light without increasing the heat of hot bodies on which they fall.

Passing now from the amusement of speculation to more serious duties, I find myself confronted with the difficulties that prevent us in this country from succeeding as we used to do in the international struggle—a struggle the issue of which is daily becoming more and more a question of brains, of education, of skill and enterprise in manufacture—and finally of that great virtue extolled by the President of the United States, strenuousness.

It is the duty of everyone who sees the way in which we are being outstripped in the race to do what in him lies to scrape off the rust which is clogging our educational machinery. I now refer to the defects which hamper the intellectual progress of the majority of our youth. I believe the public school mathematics in this country stands on a level of its own, well below that of any other. In England, owing to our complicated system of weights and measures, which our Ministers and our Parliament dare not abolish for our own good, the scanty hours allowed for mathematics are devoted to the learning of tables which should never have to be learned at all, to compound reductions designed merely to puzzle but not to lead to any new step; and, even if our present system were not futile enough, to learning lists of antique values which serve the useful purpose of giving the boys something to do. The result is that beyond having time to acquire a few elementary algebraical rules the boy is never introduced to algebra proper; he has no idea of algebraical reasoning; his trigonometry often does not exist, and the very sound or suggestion of coordinate geometry or of the differential calculus, which might be well within his reach, produces a shiver of dismay. Geometry is presented for the first time in the form of Euclid, a form as repulsive to most boys as it well could be. I must confess to having been attracted and not repelled by Euclid; but the boy does not care for time. Now that I look at Euclid again I have also to confess that any lingering regard for an old friend vanishes before the archaic language and the unnecessary circumlocution. If Euclid must be retained let it be translated into English, the English that any parent would use in explaining the ideas to his son; let it be illustrated by constant reference to real things so as to appeal to the boy who does not revel in the abstract. Let the ideas and the terms first be presented in the form of experiments and of measurements with instruments; let the schoolmaster dare to throw over the intolerable conservatism which prevents our doing anything ten times as well lest some item should prove to be a trifle worse; in fact, let us take some heed of the possibly extreme, but none the less genuine and valuable preaching of Prof. Perry. I have so far referred only to the miserable use that is made of the odd hours grudgingly given to what is called mathematics. Is it any use to repeat the long-standing complaint of the way in which the schoolmaster insists upon overdoing his Latin and Greek under the belief that they are at least essential to intellectual development if, indeed, they do not supply the only stimulus? As society is constituted they are essential to education as an extensive knowledge of Confucius is essential to an educated Chinaman, so that we may mix one with another, appreciate the works of our great authors, understand the same allusions, and have the same kind of knowledge of the development of our civilisation. Few men of science, perhaps none, wish to see all of this, some of which is essential to a general education, abolished; all that we ask is that the schoolmaster shall not continue to impose upon the community the unbalanced learning which corresponds to mathematics and science without letters. The time given to classics is exorbitant; more must be reserved for those pursuits which draw out the habit of independent thought, creation and originality. It would be well if every schoolmaster could read an admirable article by James Swinburne on the two types of mind fostered by the two complementary types of education, but this is buried away in an inaccessible number of the *Westminster Review*.

The classic is unfortunately still in possession, and where, as is still often the case, he is innocent of any appreciation of the educational value of post-Newtonian studies it is not surprising that he thrusts into odd moments the subjects he does not understand, and which he therefore despises, and that the boys committed to his charge and living in such an atmosphere are half ashamed of showing any interest in the scanty science which is within their reach. It is almost impossible to believe that such can be the case, but I have referred to the impression to which the appointment of the first science master at my own school gave rise. I now refer to the contribution to a discussion on education but a year or two ago by that experienced teacher, Principal Griffiths. Fortunately our public schools are not the only ones in the country. Smaller and less fashionable schools pay more attention to education and suffer less from what, in defiance of all rule, I can only call didactatorial method.

I am not aware that the result of this almost total exclusion of tabooed subjects in favour of Latin and Greek is producing a standard of classical attainment in our youth greatly in advance of that to be found in other countries, but it is certain that in history, modern languages, mathematics, and science the product of our public schools is sadly deficient.

There is another point related to our deficient general scientific training on which I wish to offer some remarks, and that is in relation to manufacture. It is the fashion among some of our scientific people to talk of our manufacturers as if they were a very ignorant lot and to suppose that one word from some professor who has never seen outside a laboratory would be sufficient to put them right. Now in my somewhat varied experience I have had occasion to become acquainted with corners of our great manufacturing areas, and while my experience is small and not enough to generalise upon, it is nevertheless several times as great as that of some who are ready to adopt the superior attitude, but have none.

The loss of one industry after another is only too patent. In so far as this may be due to want of enterprise in our men of business we are not concerned with the cause in this Section; in so far as it may be due to want of that little assistance which the fiscal arrangements in other countries make possible for our rivals again we are not concerned in this Section; in so far as our patent laws are unique among those of manufacturing nations in allowing the foreigner to manufacture in his own country under the protection of our patent law, so that the most valuable school we possess, the manufactory, as well as the manufacture, is conducted to the advantage of our rivals—a point which I suppose it is unnecessary to commend to the notice of Mr. Chamberlain—with this, too, we have no concern in this Section; but in so far as this, or the want of enterprise or of foresight that leads to it, is due to ignorance and to want of appreciation of scientific advance we are very much concerned with it. If I may refer to my own limited experience, there is a lamentable contrast in the manner in which a great number of our own countrymen look at any proposition put before them and that in which the alert American does. It is useless to explain that which would be self-evident to a man with a moderate knowledge of chemistry and physics such as our schools ought to supply, or for which they should at least lay the foundation, for the words have no meaning; they are merely words. He distrusts anything new; he has heard of a new process before that did not work out well; experience on the Continent to him is no experience at all, for he believes the inhabitants in such distant parts of the earth are not capable of knowing as well as the enlightened Englishman whether a thing is properly done or not, and so he goes on as he did before, perfectly content. This attitude would not be possible with the most elementary understanding of common principles.

But there is another side to this picture. Anyone who has discussed any scheme with the board of directors, the manager, the engineer, and the chemist of one of our great manufactories must have been struck with the concentrated ability there found in harness. It has often seemed to me that it is a great misfortune that our professors of mechanics, of physics, and of chemistry are in so many instances precluded from a better acquaintance with the working of these great machines—a misfortune not for the works, at least directly, but for the professors, and more especially for their pupils.

Nowhere are scientific problems of greater complexity constantly having to be solved than in a great manufactory; nowhere is such concentrated talent necessary as in a works organised and carried on in competition with all the world. I look upon these as our most valuable schools, and the closer the touch between them and those whose province it is to teach, the better for the teacher and the pupil.

It is, perhaps, hardly desirable to mention any one where there are so many. I am tempted to dwell upon the problem which has been at last successfully solved by Parsons, this being the joint product of the school and of the works; but there is one picture—a contrast, I will not say of light and shade, but of colour and colour—to which I must refer. I remember in my early days, in the surroundings of a classical atmosphere, the general feeling of contempt for the manufacturer, the intellectually inferior creature who only made money, but who knew nothing of τύπτω or τέτυμμαι. I am not sure that some such feeling does not still exist among those whose horizon is limited to the Latin and Greek that they have learned—or should I say limited *by* instead of *to*? This recollection came back to me when not long ago I was visiting one of the best organised and most skilfully conducted works in the country—I mean Willans and Robinson—when I remembered that another great manufactory, conducted on American lines, was near by, and when across the road I saw the walls of one of our most famous English schools. I pictured the old contrast: on the one hand the conviction impressed upon me when a boy that there is something intellectually superior in the struggle with a paragraph of Xenophon or a page of Homer, while manufacture is merely mechanical, sordid and base, with what I believe to be the reality on the other. I wondered in what spirit the erection of these works was viewed at the school and to what extent the high intellectual attainment there so essential and so evident is properly appreciated.

Of the last of the three headings, Strenuousness, we have plenty, but at school it is most apparent in cricket and football, and in after life in various expensive ways of murdering defenceless animals.

However, a change is already beginning to be felt. The public schools no longer withhold the elements of chemistry and physics, and those who have benefited, even in small degree, are taking responsible places vacated by those who had no such opportunity. The numerous polytechnics are providing more serious instruction to thousands of our young men, and it may be hoped that in time even the official—I mean the mere official whose only conception of activity is centred in obstructing progress and enlightenment—will have some appreciation of things as well as of words.

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY PROF. SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

AT the last meeting of the British Association which was held in Southport, the President of Section D, Prof. E. Ray Lankester, delivered an impressive address on the provision in this country for the advancement of Biological Science, in which he pointed out the very inadequate encouragement which existed at that time for those who, by education and inclination, were fitted to pursue original investigation in Zoology and Botany. Twenty years have passed since that Address was written, and yet we have to acknowledge that, notwithstanding the important part which our branch of Science has played in contributing to the sum of useful human knowledge during the last two decades, the progress made in the direction indicated by Prof. Lankester is far from satisfactory. I do not propose in this Address to make any detailed statement of the number of posts in this country that are now open to zoologists, or of the amount of the present-day endowments for the encouragement of Zoological Science as compared with those of twenty years ago; but I wish to point out that neither in the older Universities of Oxford and Cambridge, nor in the Colleges and National Institutions situated in London, nor in the newer Universities and Colleges of the provinces, have any new posts been created or adequately endowed which enable the holder to devote a reasonable amount of his time to the pursuit of biological knowledge. It is true that there are a few more posts now than there were, in which a small stipend or salary is offered to young trained zoologists for their services as teachers of Elementary Biological Science to medical students and others; but the emoluments of such posts are so small, depending as they do, almost entirely, upon a share of the fees paid by the students, and the duties so arduous and prolonged, that they really offer very little inducement to the pursuit of continuous and systematic original research.

In one respect, however, we may notice and acknowledge, with gratitude, an improvement in our position. In the laboratory accommodation, both in our Universities and on the sea coast, we are a good deal better off than we were. Twenty years ago there was no biological laboratory on the whole of the long line of the British Coast. Now, thanks to the efforts made by biologists and their friends, we have at Plymouth an institution for the study of the marine fauna and flora under favourable conditions, and similar institutions at Port Erin in the Isle of Man, at Piel, at Millport, and at St. Andrews, and a provisional laboratory for the study of fishery problems at Grimsby. New laboratories for the study of zoology have also been built at Oxford, at Cambridge, at the University of Manchester, at Edinburgh University, and elsewhere, and I may add that a fine new laboratory is now in course of construction for the department of Zoology in the University of Liverpool.

These new institutions, however, only emphasise, they certainly do not ameliorate, the weakness of our position in having so little encouragement to offer to competent and well-trained men who wish to devote their lives to the advancement of Zoological Science. Moreover, I would point out that these institutions have been built and are being maintained almost entirely by funds supplied by private benefactors, or out of the inadequate resources of the Universities.

The Treasury has made a provisional grant of 1000*l*. per annum towards the maintenance of the work done by the Marine Biological Association, and it may be supposed that a small share of the annual Government grant made to the University Colleges and Scotch Universities goes to the support of the zoological departments; but, apart from this, there has been no increase in the support given to us from public funds.

If we were to compare our progress in the matter of the public appreciation of our science during the past two years with that in other countries, we should find that our position is by no means satisfactory. In Germany, France, Belgium, Holland, and more particularly in the United States of America, progress has been rapid and continuous. The number of persons in these countries who by the aid of university or public endowments are able to devote themselves to original work in zoology has considerably increased of late years, and the number of magnificently equipped institutions that have been built for their accommodation and convenience makes our efforts in the same direction appear very small.

It would not be difficult for me to bring facts and figures before you in support of these general statements; but my object is not so much to lament over the past and to mourn for the present position of our science in this country, as to suggest directions in which we may work together for its development and progress.

Upon one matter, however, I think we may congratulate ourselves. If the research done by English zoologists has not been as great in amount as it might have been, I think it may be truly said that we have fully maintained its standard as regards quality.

The contributions that have been made to the Science of Zoology by our countrymen during the past twenty years in general interest and in theoretical importance are of such a nature that any civilised race might well be proud of

them, and I venture to say they compare favourably with those of any other country. I may remind you that the discovery and description of the Okapi, Cænolestes, Nyctotherus Rhabdopleura, Cephalodiscus, Limnocodium, and Pelagohydra, the rediscovery of Lepidosiren and Ctenoplana, the most important features of the development of Balanoglossus, Lepidosiren, Amphioxus, Peripatus Hatteria, and some of the Marsupialia, and that the discovery of the important character of the fauna of the deep seas involving the discovery of many new genera and species, were the work of British zoologists. Moreover, that the prolonged and painstaking investigations carried on in our laboratories have thrown much light upon the character and relations of cœlomic cavities, the homologies of the nephridia and genital ducts, and many other important morphological problems.

In the field of evolutionary theories we have done much important work in the study of the facts of protective and aggressive mimicry in insects, in the statistical estimation of variations, and in the experimental inquiry into the value of current theories of heredity.

The list is far from complete; but with such a record of good work done with the scanty means at our disposal there is no reason to suppose that the science is on the decline in this country, or that our countrymen are not as capable as any others of grasping the importance of biological problems and ultimately wresting from Nature the secrets that are hidden.

Whilst we may thus congratulate ourselves upon the achievements of the past and upon our strength and ability to carry on good work in the future, I cannot help feeling that the time has come for us to make a united effort to place before the general public of this country, and more particularly the educated and influential part of it, the disadvantages under which we suffer, and our need for help in the further development of our subject.

We have all realised that in this country, more than in any other that is called civilised, there prevails among all classes an extraordinary ignorance of the first principles of biological science. It is this ignorance on the part of the general public, I believe, which prevents us from gaining that sympathy for our aims and that assistance for our efforts which we think is necessary not only for the reputation, but also for the welfare of our country. We must remember that the science of Natural History is as a closed book to most of those who after a public school and university education have attained to positions of trust and responsibility in the government of our country and our cities. Moreover, and this is perhaps the most serious aspect of the question, there are many who have gained a high position as men of science, and whose opinion is frequently quoted as authoritative on questions affecting science in general, who are more ignorant of the first principles of the science of biology than the Dutch schoolboy of fifteen years of age.

It appears to me, then, that it is of fundamental importance for the zoologists of this country to consider and report upon the necessity for the extension and improvement of the teaching of Natural History in our schools and colleges. We shall have to meet the objections that there is not time for Natural History in the school curricula, and that it is not a suitable subject for the instruction of boys and girls. These objections can be met, I believe, and overcome.

In many foreign countries Natural History is a compulsory school subject for all scholars. In Holland, for example, by the law of April 28, 1876, all scholars of the gymnasia during the first and second years devote two hours per week to the study of Natural History, and in the fifth and sixth years all students preparing for natural, mathematical, and medical sciences courses devote two hours per week to the science. In the superior middle-class schools one hour a week is devoted to the science in the first and second classes, and two hours per week in the remaining three years. If, therefore, time can be found in the middle and upper class schools for the study of Natural History in a country like Holland, where the general education is so excellent, surely time can be found for it here.

It is also a matter for general regret that some course of Elementary Biology is no longer compulsory for those who are proceeding to degrees in science in our universities, and I cannot help feeling that a very retrograde step was taken a few years ago by the authorities of the University of London, when Biology was made an optional subject in the Intermediate Examination for the degree of Bachelor of Science. We cannot expect to receive that sympathy in our pursuits and appreciation of our discoveries which we expect from our fellow-men of science if we tacitly admit that an elementary knowledge of the laws of living bodies is not a necessary part of the equipment of a man of scientific culture.

I think we must all admit that the time is ripe for a full discussion by biologists of the particular form of teaching and study which is most suitable for schools and elementary university examinations. It is a matter in which we are all interested; it is a matter affecting most intimately the interests of those who will be our pupils in the future, and we should be careful to see that no ill-considered or fantastic schemes of study are thrust upon the authorities by unauthorised persons at this very critical period in the educational history of our country.

There are other matters, however, which also demand our careful attention. The growth of our great cities and the improvement in our ideas of sanitation have brought forward as important problems for consideration the purity of the water-supply and the disposal of sewage. The municipal authorities at last realise that these problems can only be satisfactorily met by elaborate scientific investigation, and they have found that it is not only desirable for sanitary reasons, but also—and this has probably the greater weight—profitable to call in men of science for consultation and advice. At present, however, these problems are approached from only two points of view—the chemical and the bacteriological—the effect or effects of other organisms than bacteria upon the character of the sewage effluent and the purity of water for drinking purposes being, so far as I have observed, neglected. I was very much impressed with the fact that at the meeting of the Sanitary Institute last year in Manchester the speakers used the expression "bacteriological examination" and "biological examination" as if they were synonymous, and no mention was made either of the animals or plants which are invariably present, and materially assist if they are not actually necessary for the maintenance of the most suitable balance of life in these waters. The time has come when an inquiry should be made of the organisms other than bacteria that are normally present both in the waters at the sewage works and in the large reservoirs which supply cities with drinking-water.

I may be allowed here to quote two cases that have recently come under my notice which will show the kind of work that might be done and the nature of the results which may be expected to follow such an inquiry.

Some years ago complaints were made that the water supplied by the borough of Burnley had an offensive smell. This smell was of such a nature that it was impossible to use the water for the manufacture of soda-water.

The smell was traced to the Hecknest reservoir, where the common water snail, *Limnaea peregra*, was present in enormous numbers. The problem to be solved was how to destroy or reduce the numbers of the Limnæa without interfering in other respects with the purity of the water. The authorities of the corporation asked the advice of a trained zoologist, who made certain recommendations which were adopted, and at a minimum cost the nuisance was abated, and during the six years that have elapsed has not recurred. I will not detain you with a full description of the cause and the cure of this particular pest, but I may say that the recommendations that were made were based on the knowledge of the life habits and reproduction of the Limnæa, and were therefore of a purely zoological character.

Two years ago the Chairman of the Water Committee of the Corporation of Manchester reported that the mains had become partially choked by the growth of an organism which he called a "moss." No less than 700 tons of this "moss" were removed from the mains by a laborious and expensive process. It is not necessary for me to inform this Section that the organism was not a moss. It was probably not even a vegetable, but an animal belonging to one of the genera of fresh-water Polyzoa. In this case, however, so far as I am aware, not only were no steps taken to identify the organism, but no investigations were made to discover its origin or to prevent the return of the

trouble in the future. I could give you several other examples which show that our ignorance of the general balance of animal and vegetable life in the large reservoirs is profound, and that a systematic inquiry conducted by competent persons would most certainly lead to knowledge which would be of great scientific importance, and in the long run remunerative to the community.

I do not think that we can expect that any one of the municipal authorities will feel justified in bearing the cost of such an investigation. The problems that one corporation has to face are very much the same as those that others have met; and each corporation hopes to profit by the successful and neglect the unsuccessful experiments of its neighbours. An investigation such as this, which is really for the benefit of the whole community, should be conducted by a central authority at the public expense.

The scientific investigation of the problems that are connected with the maintenance and extension of our sea fisheries is another matter that requires the very careful attention of the zoologists of the present day. The valuable work that has already been done by the officers of the British Marine Biological Association, the Lancashire Sea Fisheries Committee, the Scottish Fishery Board, and other bodies is of a nature sufficiently encouraging to justify us in asking for the necessary means and appliances for still further developments of the inquiry. There is, however, a great need for a free discussion by those who are competent to speak on the subject to determine and, if possible, to come to some conclusion upon the question of the best and most profitable lines that the inquiry should take in the immediate future, and the establishment of such co-operation as is necessary by the different authorities to prevent duplication where it is unnecessary, and simultaneous observations of similar phenomena on different parts of the coast when it is considered desirable. The report of the Committee on Ichthyological Research, 1902, has shown that there is already in this country a good deal of activity in various branches of investigation of the fisheries problems, but the authorities are not on all points in agreement as to the best plan or course to pursue in future. I cannot but hope that if some conference were held, at which those zoologists who have made a special study of these matters were present, the principal differences of opinion might be cleared up and a unanimous report presented to the authorities.

I have felt very strongly for some time past, and I know there are many of my colleagues who agree with me, that the zoologists of this country are under some disadvantage in not being provided with the necessary machinery for full discussion of matters which affect the welfare of the science as a whole. There are several societies which receive, discuss, and publish papers on various branches of zoological research, but they do not, and from the nature of their constitution cannot, give effective utterance to the general or unanimous opinion of professional zoologists on matters of their common interests. There is no society which all serious students and teachers of zoology feel is the one society which it is their duty and in their own interests to join. Some join the Zoological Society of London, others the Linnean Society, others, again, the Royal Microscopical, Entomological, or Malacological Societies, or some combination of two or more of them. There is no common ground on which we meet for the discussion of such subjects as those I have just mentioned in this Address. In the early days of the British Association this Section supplied the needs which we feel now. It was the Society, if I may call it such, which all the zoologists of the time made a special effort to attend. Important matters were fully discussed by the most competent authorities, and people felt that the prevalent opinion on any subject expressed by Section D was the prevalent opinion of men of science throughout the country.

In concluding this portion of my Address, I may express the hope that when the Association meets next year at Cambridge some steps may be taken to render the organisation which we already possess in connection with this Section more generally useful and more efficacious than it is at present.

In the opening sentences of my Address I used an expression which some of my hearers may have considered open to criticism. Let me take this opportunity of saying, then, that by using the expression "useful human knowledge" I did not intend to express an opinion that there is any knowledge of the character that is expounded and discussed in these sections of the Association which can be called useless knowledge.

A distinction, however, is frequently drawn between knowledge that can be directly applied to the arts and crafts and knowledge which, on the face of it, appears to us at present to be only of general scientific interest. For example, in the award of the Exhibition (1851) Scholarships and Bursaries, the candidates must still give evidence of capacity for advancing science or its application by original research in some branch of science, *the extension of which is especially important to our national industries.* We can rejoice most cordially in the successful developments of the technical institutions in the country, we can heartily join hands with our colleagues in other sciences in urging upon the authorities the encouragement of those branches of science which have a direct bearing upon our industries, but we have a no less important duty to perform in claiming for those branches of science that have apparently no such direct application the needful sympathy and encouragement. I venture to say that at the time the Association last met in Southport no one would have ventured to predict that the study of the anatomy and life-history of the Diptera, or the general biology of the minute sporozoa, would have any direct bearing upon the development of our industries. But to-day, by our knowledge of the mosquito Anopheles, and the sporozoan parasite it carries, we are in a position to destroy or ameliorate the malaria pest which has hindered the commercial development of so many of our colonies in tropical countries, and by encouraging the development of such countries we are assisting to a very material extent our home industries and the general trade of the country. In this, as in so many other cases, the benefit to industry and commerce has come from an unexpected quarter of the field of zoological research. Those who were working within the narrow limits of what is called applied science could never have discovered the facts which we now regard as of extreme importance, however well equipped they were with laboratories and appliances and endowments for research.

It will be of very little profit to this country to endow munificently the technical institutions and those branches of science to which the adjective "applied" is given, to build British "Charlottenburgs," and to attract by handsome salaries the most distinguished professors to the study of the application of science, if at the same time we starve and allow to sink into insignificance the fundamental sciences upon which the whole superstructure rests. It does not need a prophet to foretell that a great disaster will occur if we add story to story of our house of education without widening and broadening the basis upon which it rests.

Many of us, I am afraid, are too much inclined to believe that the intellectual portion of the community has at last awakened to the importance of the work in the fields of pure science, that the old prejudice against us who indulge what is called our harmless curiosity is dying out, and that our science is bound to receive a fair share of encouragement and attention in the progress of the modern developments of science and learning.

The distinction that is drawn between pure and applied science is, however, in danger of being broadened and deepened rather than diminished by the recent activity in the foundation of schools and colleges for technical instruction. There are, it is true, several eminent and distinguished persons who recognise the danger and do their best to avoid it, but this fact is not in itself sufficient to justify us in any relaxation of our efforts on behalf of the maintenance and development of those branches of the sciences which are usually supposed to have no direct or technical application.

In the wide field of zoological research there are many subjects now being investigated and discussed which, at present, seem to us to have but a remote bearing upon any practical problem of industry or medicine. Of all these subjects there are two which have excited during the past ten years extraordinary interest, and are from many points of view subjects of greatest possible importance. I refer to the subject of the natural variations of animals and plants, and the problem of the hereditary transmission of characters from generation to generation.

At present there appears to be some doubt whether the workers in these subjects are really agreed as to the general propositions of the problems, the definitions of the terms employed, and the standard of proof that is requisite in each step of progress. It is true that in most, if not in all, biological problems we are at the disadvantage of being unable to define or measure anything with the same mathematical accuracy that our friends, the chemists and physicists, are accustomed to. We cannot say for example that the chela of a particular species of crab is so many millimetres in length, in the manner the chemist determines the atomic weight of a new metal, as the length of the chela is found to vary within a certain range in all species that have been investigated; nor can we define such common expressions as a species, a variation, or even a cell with the same conciseness as a physicist defines the ohm, the volt, specific gravity, or the mechanical equivalent of heat. As a consequence it is not surprising that when our problems have been studied and a solution reached the resultant "laws" exhibit so many exceptions that they are really not worthy to be called "laws" at all. We may see the truth, but we see it as through a glass, darkly.

There is perhaps no word in the whole of our vocabulary which is used in so many different senses as the word "variation," and yet when it is used an attempt is only rarely made to define the sense in which it is employed.

When we study the adult progeny of a single pair of parents we notice that they differ from one another as regards any one particular character within a certain range. Thus the eight children of a single pair of human parents may vary in weight from, say, 130 lbs. to 200 lbs., and we may find that the average weight of the eight children is approximately the same as the average weight of the two parents. If parents and children were all of exactly the same weight—an impossible supposition—it would be said that they exhibited no variation in this respect, but, as they always do vary in weight, it is said that they exhibit "variations" in weight. Now, such variations may be due partly to differences in the muscular training, the nourishment, the general health, and other post-natal causes; but it is assumed, and there are doubtless good reasons for the assumption, that if all these post-natal influences had been equal throughout life there would still remain variations in weight of lesser amplitude than is usual, but nevertheless substantial.

The variation of the adult in weight, therefore, is a compound quantity, partly due to the influence of external conditions upon the growing body, and partly due to a quality or character present at birth and usually supposed to be inherited with the germ-plasm from one or both parents. The former may be called the artificial part of the variation, or for brevity the artificial variation, and the latter the natural or inherited variation. In the character of weight in human beings there can be no doubt that artificial variation is predominant, the character being a very fluctuating one and liable to profound modification in the varying vicissitudes of civilised human life.

In the character of stature the artificial variation is probably much less predominant. The children of tall parents grow into tall men and women, however handicapped in early life by ill-health or insufficient nourishment, and the children of short parents remain short in adult life, however healthy and well fed in their youth. Nevertheless, he would be a bold man who would assert that the character of stature is uninfluenced by the environment, and that the short people would not have been taller had the conditions of their life in childhood been more favourable, or the tall people shorter if the conditions in their early life had been less favourable.

Finally, we have, in the colour of the iris, the shape of the ear, and the size of the teeth, characters which are usually considered to be unmodified by post-natal conditions, or at least so slightly modified by them that the differences observed in them may be regarded as almost pure natural variations. Now, if we turn our attention to characters such as weight, which we feel certain are influenced very profoundly by the environment, we might be tempted to exaggerate the importance of the environment in moulding or forming the characteristic features of the adult organism, as, in the opinion of many authorities, Lamarck did, and many of his followers are still doing. If, on the other hand, we confine our attention to such characters as the colour of the iris or the shape of the ear, we might be tempted to under-estimate the influence of the environment.

This brings us to the important question whether the characters of the adult that are due to the influence of the environment, and that part or degree of any character which is more or less modified by the conditions of the earlier stages of life are or are not transmitted by parents to their offspring. Time will not permit me to discuss this difficult problem here. Rightly or wrongly, I agree with those who maintain that acquired characters are not inherited, and I intend to assume for the purpose of the argument that follows that they are not inherited. I will also assume, and I must say that the facts seem to be conclusive in favour of this assumption, that the characters which are usually supposed not to be influenced, or to be only slightly influenced, by the environment are capable of transmission by heredity.

We have, then, in most variations a part that can be transmitted and a part that cannot be transmitted by heredity from parents to offspring, and we find in every plant and animal an enormous difference in the proportions of these two parts in different organs. It is not difficult to see the general reasons for these differences. It is clearly important that some organs should be plastic—*i.e.* capable of changing in form and size to meet the varying changes in the environment, and that others should remain relatively constant in spite of changes in the environment. Thus the shape and size of the branches of an oak in a plantation will vary enormously, according to the light and space they have for their development, whereas the anthers, the pistils and fruit will be relatively constant in form and colour. It is clearly important for a chamæleon that the colour of its skin should vary according to the colour of its environment; but it is none the less important that the shape and muscular organisation of its tongue should remain relatively constant throughout life.

An essential point, however, for us to consider is whether there are any characters in animals or plants upon which the environment exercises no influence at all or exercises such a slight influence that it may be safely neglected. The method to adopt in order to settle this point would be to compare at a definite period of their lives the statistics of variation in a family or population which has been brought up under identical circumstances with those of a similar family or population at the same period of life which has been brought up under differing circumstances. If this were done we could determine with considerable accuracy the proportion of the variation of any character of the individuals that is due to the environment and that which is natural and inherited.

Unfortunately it is impossible to bring up a population under identical circumstances. If we take, for example, the individuals of a single hive of bees, which have the same parents, pass through the early stages of their development in cells which are almost identical in size and are regularly fed by the workers during the whole of their larval life, there is still a considerable probability that the individuals do not have a treatment which can, with any pretence to accuracy, be called identical. The food that is collected by the worker-bees frequently comes from varied sources or from flowers in different stages of their growth, and it is impossible to believe therefore that it has always identical nutritive properties; the larvæ are not of the same age, and seasonal changes may affect the larvæ differently, some being checked in the early stages of their development more than others.

But even if we could, with justice, assume that the conditions of life for the individual bees in a hive are identical from the time of hatching up to the time when the adult characters are assumed, there still remain two sets of variable conditions which must affect the development independently of the influences brought by the two parents in the germ-plasms.

In the egg of the bee there is a considerable quantity of yolk, and this yolk is the food material upon which the embryo is nourished throughout the earlier stages of its development. There is no evidence that the yolk in the eggs of this or of any other animal is constant either in quality or quantity. On the other hand, the extraordinary variations or abnormalities, as they are usually termed,

which the embryologist meets with in the segmentation of the egg suggest that there are considerable differences in these respects between the eggs laid by a single parent in a single act of oviposition. Moreover, the manner in which the young eggs of the insects are nourished in the tubular oviduct before they are ready for fertilisation gives very little support to the view that the amount of yolk deposited in each egg is identical.

The second consideration under this heading is possibly of even greater importance. Vernon[1] has shown that the size and other characters of echinoderm larvæ vary very considerably according to the freshness or staleness of the conjugating ova and spermatozoa. For example, he found that when the fresh spermatozoa of Strongylocentrotus fertilised the eggs which had been kept eighteen hours of the same animal, the larvæ differed from the normal larvæ, −17·6 in body length and −15 per cent. in arm length, and when the fresh eggs were fertilised by spermatozoa which had been kept eighteen hours the resulting larvæ differed from the normal by +11 per cent. in body length and by −32·8 per cent. in arm length.

This consideration is practically eliminated in the case of the worker-bees by parthenogenesis, but it cannot be set aside in the case of the drones nor in the cases of the broods of other animals which do not exhibit the phenomenon of parthenogenesis. A comparison of the curve of variation of some character, common to both, in drones and worker-bees from one hive would perhaps throw some light on the general importance of this character.

Before leaving this part of the subject, I must call attention to two results bearing upon it, obtained by De Vries in his botanical investigations, and related by him in his very important work entitled "Die Mutationstheorie." This observer found that the younger the seedling is the greater is the influence of external circumstances upon its adult characters, and in the second place that an even greater influence is exerted upon the characters of a plant by the external circumstances affecting the mother-plant. If these results hold good for animals as they do for plants, we should expect to find, then, that the external circumstances affecting the mother at the time she is maturing the eggs in her ovaries and the external circumstances affecting the embryo before and during the larval period are of far greater importance in affecting the curve of variation of the adults than are the external circumstances affecting the young in their period of adolescence. We must come to the conclusion, from these considerations, that the general variability of a brood or progeny of a single pair of parents must be very largely the effect of the varying conditions affecting the gametes from the earliest stages of their genesis in the gonophore, the fertilised ovum, and the early stages of development. We find, however, as I have already pointed out, that some characters are much more influenced by external circumstances than others. Weight and stature in human beings, for example, are probably much more influenced than the colour of the iris or the shape of the fingers. We may, indeed, recognise two kinds of characters, connected, of course, by a complete series of intermediate links, which may be called, for convenience sake, plastic characters and rigid characters.

Now, in some animals, the characters that are rigid are much more numerous than they are in others. For example, adult salmon or perch are much more variable in size and weight than adult herrings or mackerel; some species of butterflies are much more variable in the colour and pattern of their wings than other species; some species of birds are much more variable in their plumage than others are. Several other examples could be chosen to illustrate this point from the higher groups of animals; but I wish particularly to call your attention to several instances found in the Cœlenterata, because it was the special study of this group of animals that led to the train of thought I have ventured to put before you.

In all the sedentary forms of Cœlenterates the mouth is surrounded by a circlet of tentacles. These organs are used for catching and paralysing the prey and passing it to the mouth to be swallowed. They are also very delicate, and indeed the only specialised organs of sense performing a function similar to that of the feelers or antennæ of Arthropoda. There can be no exaggeration in saying, therefore, that they are of the utmost importance to the animal. In some groups of Cœlenterata, however, we find that they are fixed in number, but in others that they are variable.

[1] H. M. Vernon: "The Relations between the Hybrid and Parent-forms of Echinoid Larvæ." *Phil. Trans.* 1898, B. p. 465.

In the Alcyonaria, for example, the number of tentacles of the adult polyp is eight. I have examined many thousands of polyps belonging to the suborders Stolonifera, Alcyonacea, Gorgonacea, and Pennatulacea, and I have not found a single example of an adult polyp with either more or less than eight tentacles. This is a character, then, which is remarkably well fixed in the Alcyonaria. It does not fluctuate at all. The tentacles of the Hydrozoa, and of many of the Zoantharia, on the other hand, fluctuate considerably in number. In some forms, such as Tubularia among the Hydroids, and Actinia among the Zoantharia, the number of tentacles is considerable, and it is not, perhaps, surprising to find variations in their number. But in many cases, when the number of tentacles is small, there is also frequent variation. In *Hydra viridis*, for example, the number of the tentacles is 6, 7, or 8, and more rarely 5 or 9.

Again, in the Alcyonaria, the number of mesenteries of the adult polyp is always eight; never more and never less.

In the Zoantharia, on the other hand, the number varies not only in different suborders and families, but even in different individuals of the same species from a single locality. Parker found, for example, that the number of non-directive mesenteries in the sea-anemone *Metridium marginatum*, collected at Newport, R.I., varied from four to ten pairs in those forms with the normal number (2) of directive mesenteries, and that there were further variations in the number of non-directive mesenteries in those forms with an abnormal number of directive mesenteries. In fact, of the 131 adult specimens collected, only 40 or about 33 per cent. exhibited the arrangement of mesenteries which is regarded as normal for the species. On the other hand, Clubb found that of the specimens of another common sea-anemone, *Actinia equina*, only 4·24 per cent. showed variations from the normal mesenterial arrangement for the species. We have then, in these examples, a set of organs which are very variable in one genus (Metridium), much less variable in another (Actinia), and perfectly fixed or rigid in another series of genera (the Alcyonaria).

Passing on, now, to the character "shape." Not many years ago the systematic zoologists, who directed their attention to the sedentary Cœlenterates, based their specific diagnoses very largely on the shape of the colonies. Thus we have introduced such names as *Millepora alcicornis, M ramosa, M. plicata, Madrepora cervicornis, M. prolifera, M. palmata, Alcyonium digitatum, A. palmatum*, &c. Zoologists are now agreed, however, that the shape of these colonies is so variable that in most genera it is of very little value for the separation of species. In fact, I have elsewhere given reasons for holding the view that the widely distributed and very variable genus Millepora is represented by only one true species. But what is true for most sedentary Cœlenterates is not true for all colonial Cœlenterates. In most of the genera and species of Pennatulida, for instance, the shape of any one individual of a species is almost identical with that of any other. A *Funiculina quadrangularis*, from the west coast of Scotland, is similar in shape to one of the same species from the coast of Norway. A *Pennatula murrayi*, from the reefs of Funafuti, is similar in shape to one from Ceram. In other words, the character "shape" is extremely plastic in Millepora and Madrepora, but very slightly plastic or almost rigid in Pennatula and Funiculina.

This difference in the plasticity of the character "shape" in Millepora and the Pennatulids must be associated with the fact that the young Millepora colony is unable to move from the spot where the larva settles, whereas the Pennatulid is capable of moving from place to place throughout life. The Millepora colony must either accommodate itself to the environment in which it begins life or perish, but the young Pennatulid can, within certain limits, travel to the environment that suits itself.

The shape of a growing coral or sedentary Alcyonarian on a reef must accommodate itself to the depth of water, the position of neighbouring zoophytes to itself, the direction of the tides, and other influences; and such a power of accommodation is essential for the species in the struggle

for existence on the coral reef. But in the case of the Pennatulid, the natural or normal shape is adapted to a less variable series of environmental conditions, and it has sufficient power of movement to shift itself into localities where the environment is suitable for it. In other words, the power of movement is associated with a loss of plasticity of the character "shape."

But the growth of corals may be affected in other ways. A great many of these forms of life harbour a small fauna of epizoic crustacea, mollusca, and worms, and the ramification or surface is often affected by these in a remarkable way. I have elsewhere pointed out that the character of certain specimens of Millepora, which is known as verrucose, is due to a modification of the growth round epizoic barnacles. Semper has shown that the curious cage-like growths seen on the branches of Seriatopora and Pocillopora are galls produced by the action of certain species of crabs. In a recent paper I have also given reasons for believing that the tubular character of the stem and some of the branches of the genus Solenocaulon is due to the action of certain crustacea belonging to the family Alpheidæ, and that when these Alpheids are not present the form with a solid stem hitherto known as the genus Leucoella is produced.

But whilst some genera of corals and Alcyonaria are plastic in this way, others are not. These coral galls may be found on the Milleporas and Madreporas of a certain portion of a reef and be absent from all the other genera of neighbouring corals. The crab-galls that are found so commonly and in such abundance upon Pocilloporas and Seriatoporas in certain parts of the Pacific and elsewhere are found only in cases of extreme rarity in other corals.

Many other cases could be given to show that in some genera the cœnenchym is remarkably plastic or accommodating to these epizoites, whereas in others it is resistent and rigid.

The size and shape of the spicules have been taken as characters for the determination of the species of Alcyonaria. It is true that in some species the spicules are remarkably constant in size and shape, but in others they are extremely variable. The remarkable torch-like spicules of the cœnenchym of *Eunicella papillosa*, the club-shaped spicules of Acrophytum, and the needle-shaped spicules of many species of Pennatulids are remarkably constant in size and shape, but in Sarcophytum, the new genus Sclerophytum, Siphonogorgia, Spongodes, and a great many others, the size and shape of the spicules are extraordinarily variable. In the matter of colour, too, we find the same thing. The genera Tubipora and Heliopora are widely distributed in the shallow waters of the tropical seas and are very variable in many of their characters, and yet there is not a single specimen of Tubipora known that is not red, nor a single specimen of Heliopora that is not blue. The same may be said for several other species. On the other hand, many species of Alcyonaria are extremely variable in colour. Thus, *Muricea chamaeleon* is, according to Von Koch, sometimes yellow, sometimes red, and in some cases specimens show both red and yellow branches. The specimens of *Melitodes dichotoma* in Cape waters are sometimes red and sometimes yellow. In a small species of Melitodes from the Maldive Archipelago there is a very remarkable degree of variation in colour both in the nodes and internodes, the details of which I have briefly described in vol. ii. of Mr. Gardiner's Results. In the genus Chironephthya, also from the same Archipelago, the variations in colour are very remarkable, the spicules of the general cœnenchym showing various shades of red, pink, yellow, and orange, and the crown and points purple, yellow, and orange colours which sometimes agree, but usually do not agree, with the general colour of the cœnenchym. The variability of the genus is particularly interesting, as in Siphonogorgia, the genus which comes nearest to it, and is, in fact, difficult to separate from it, the colour of the cœnenchym is almost invariably red.

To summarise this knowledge of variability in the Cœlenterata we may say that we find either extreme plasticity or remarkable rigidity in many of their most important characters. Such important and essential organs as the tentacles, stomodæum, mesenteries, &c., are in some groups very variable indeed, and in others as stationary or fixed; we find the same with organs such as the spicules of Alcyonaria, which are, so far as we can judge, of less essential importance, and in characters, such as colour, which must be, in the sedentary forms at least, of minor importance.

If we compare this with what we find in the higher groups of animals we observe a great contrast. In fishes, to take an example at random, we may find that in such characters as the size and weight of the adults, there may be great or considerable variability, but in the essential organs, such as the heart, brain, and stomach, there is almost complete rigidity. I do not mean by using the expression "rigidity" to imply that minor variations in size and shape do not occur, but that major variations, such as a doubling of the stomach, a bifurcation of the cerebral hemispheres or other variations, which it would be considered grotesque to suggest even, do not and cannot occur. But even in minor characters, such as colour, the possible range of variation in a fish is far less than in Cœlenterates. We may find in the mackerel, for example, that individuals differ in the shade and range of the green pigment, but we do not find in any species of fish that some individuals are red, some yellow, some purple, &c.

The contrast in this respect between the Cœlenterate and the fish must be associated with their different degree of complexity of structure. In a complicated organisation such as that of a fish, the brain, heart, and stomach must mutually work together; they must be co-ordinated in form and action. Any profound variation or abnormality of one would interfere with the action of the others and would therefore be incompatible with continued existence. In the Cœlenterate, however, the doubling of the siphonoglyph, the duplication or quadruplication of the mesenteries does not, in some cases, interfere materially with the action of the other organs of the body. If we were to alter the size or shape of some part of a simple machine it might be able still to do its work the better or the worse for the change, but if we were to alter the corresponding part of a complicated machine it would probably throw it out of gear and prevent any work being done at all.

From this consideration we gather that in the process of the evolution of the higher forms of life there has been a gradual diminution in the range of variation of the different characters of the body, a gradual diminution of the response of these characters to changes of the environment. Characters which, in the early stages of evolution, were probably plastic become rigid.

The gradual evolution of the power of co-ordinated movement has been undoubtedly accompanied by a loss in the variability of the shape of the body, the gradual evolution of a blood vascular system and nervous system has led to a loss of variability in the alimentary canal with which they are associated. In the majority of cases, however, we are much too ignorant of the facts of the co-ordination of the parts of the body or of the co-ordination of any one part to the environment to be able to frame an hypothesis as to why any one character has become rigid. It is difficult to see the reason why the number of the tentacles and mesenteries in Alcyonian polyps has become fixed at eight, while in other Cœlenterates these characters are so variable, or why the colour of Tubipora is always red, and of Melitodes variable.

The study of species, however, teaches us that, in all cases, except perhaps in some examples of degeneration, the plastic condition of the characters was antecedent to the rigid, that in the earlier stages of evolution the condition of extreme plasticity and ready response to changing external conditions were necessary for the survival of the species; and that in the later stages, when special adaptations to special circumstances were developed, a certain rigidity or indifference to changing external conditions was equally necessary for its survival.

Now, the study of the various orders of Cœlenterates conveys a very strong impression that the part played by the environment in the production of the variations of the adult is much greater in proportion than it is in the higher groups of animals. It is true that direct proof of this is wanting. Such a direct proof can only be obtained by experiments in rearing and breeding under varying conditions, and there are at present many serious difficulties to overcome before experiments of this nature can be satisfactorily made.

Nevertheless, the circumstantial evidence in favour of the truth of this impression is, to my mind, so strong that we are justified in considering its bearing upon the general question. It is quite impossible for me on this occasion to set before you at all adequately the general nature of this circumstantial evidence. To do so would involve statements concerning the actual variations of a large number of species already observed in one locality and in several widely distributed localities, with a discussion of the possible direct influence of the conditions of such localities, so far as they are known, upon each of the principal variations. Such statements would necessarily be of such a special and technical kind that, even if time permitted me to make them, they would not be suitable for an Address of this character. I may be permitted to say, however, that I am collecting and preparing the evidence for publication on this point at a later date. There can be no doubt, however, from the evidence I have already submitted to you in part, that some species are far more influenced by changes in the environment, or, to simplify the expression, are far more plastic than others; and we may conclude that in the evolution of other groups of animals the earlier forms were far more plastic than their modern descendants. In the earlier stages of evolution there must have been in the first instance a lessening of the power of change in structure according to change of environment. The fixity or rigidity of certain characters thus produced enabled a more elaborate co-ordination both in form and action to occur between one set of organs and another. It permitted a further localisation and specialisation of functions, or, in other words, further differentiation of the animal tissues.

Accompanying this differentiation there was a loss in the power of regeneration. As Trembley showed many years ago, a Hydra can be cut into many pieces, and each by the regeneration of the parts that are missing will give rise to a complete individual. The Earthworm can, when cut in half, regenerate a new tail but not a new head region. An Arthropod dies when cut in half, but has the power of regenerating new appendages in place of those that are lost. But in Vertebrates there is very little power of regenerating new appendages, and the general powers of regenerating new parts are reduced to a minimum.

Now, whether the loss in the plasticity of characters was the cause of the loss in the power of regeneration of lost parts, or the loss in the powers of regeneration was the cause of the loss of plasticity, is a problem upon which I do not feel we are competent to express a definite opinion; but that the two series of phenomena are intimately associated is, I believe, a generalisation that is worth a good deal of further thought and study.

In Vertebrates, however, although the power of regeneration of lost parts is at a minimum, it is not by any means entirely wanting. The muscles, nerves, epithelia, and other tissues, are able to repair injuries caused by accident and disease. And similarly, although the power of response of various organs to the changes of external conditions in Vertebrates is very much diminished as compared with that in the lower groups of the animal kingdom, it still remains in an appreciable degree. Whether the curves of variation of the so-called fluctuating characters of Vertebrates represent simply or solely the influence of the environment on the organism cannot at present be determined with any degree of certainty; but it appears to me that zoological evidence, confirmed as it is in such a remarkable way by the recent researches of the botanists, points very strongly to the conclusion that the major part of each such curve is, after all, but an expression of the influence of the environment.

In venturing to put before you these considerations, I am quite conscious of the vastness and complexity of the problems involved and of the many omissions and imperfections which a short Address of this kind must contain. Not the least of these omissions is that of any reference to the distinction that might be drawn between continuous and discontinuous variations in the simpler forms of life. This is a matter, however, which involves so many interesting and important questions that I have felt it to be beyond the scope of my Address to-day.

We are still in need of further systematic knowledge of the widely distributed species of Cœlenterates; we want to be able to form a more definite opinion than we can at present upon the value of specific distinctions, and we need still further observations and descriptions of the phenomena of irregular facies, abnormal growths, and meristic variations. But more important still is the need of further researches in the field of experimental morphology.

When we have accumulated further knowledge on these lines in a group of animals such as the Cœlenterata, of relatively simple organisation, we shall be in a better position than we are now to deal with the problems of heredity and variation in the far more complicated groups of Arthropoda and Vertebrates.

NOTES.

THE following committee has been appointed by the Lord President of the Council to make a preliminary inquiry into allegations that have been made concerning the physical deterioration of certain classes of the population:—Mr. Almeric W. FitzRoy, C.V.O. (chairman), Colonel G. M. Fox, C.B., Mr. J. G. Legge, Mr. H. M. Lindsell, Colonel George T. Onslow, C.B., Mr. John Struthers, C.B., Dr. J. F. W. Tatham.

WRITING to the *Times*, the honorary treasurer of the Cancer Research Fund states that Mr. William Waldorf Astor has just sent a cheque for 20,000*l.* to the fund, and that, as a result of the speech delivered on July 30 by Mr. Balfour, several other donations have also been received; he points out, however, that the fund is still more than 25,000*l.* short of the amount required, and appeals for further help. The address of the fund is the Examination Hall, Victoria Embankment, W.C.

THE Paris correspondent of the *Morning Post* states that particulars of a new anti-tuberculosis serum will shortly be communicated to the Academy of Medicine by the discoverer, Dr. Marmorck, of the Pasteur Institute. The new serum is said to have been tried in the Paris hospitals, and to have cured several comparatively advanced cases of tuberculosis.

COMMANDER PEARY has been granted three years' leave of absence by the U.S. Navy Department to enable him to make another attempt to reach the North Pole. According to Reuter he will start by about July 1 next year, in a new steamer, for the Whale Sound region, where he will embark a number of Eskimos and establish a permanent base at Cape Sabine; thence he will force his way to Grant Land, where he hopes to establish his winter quarters on the northern shore. In the following February, with the earliest light, a start will be made due north over the pack ice with a small, lightly equipped party, which will be followed by a larger party. Commander Peary hopes to reach the Pole and return to his winter quarters within little more than 100 days. The distinctive features of the plan are the use of sledges with comparatively light loads drawn by dogs, the adoption of Eskimo methods and customs, and the fullest possible utilisation of the Eskimos themselves.

REUTER'S Agency learns that Major Powell-Cotton, who has been exploring in Africa for the past year, arrived safely at Wadelai, on the Upper Nile, in the middle of July, from Mount Elgon, where he had been studying the cave-dwellers. Major Powell-Cotton had had satisfactory interviews with the Congo officials, and was then preparing to start on an expedition in search of okapi.

A TELEGRAM from Mombasa on Saturday last states that Lieut.-Col. Bruce, who, with Dr. Nabarro, was despatched from London in February last, on behalf of the Government and the Royal Society, to study the sleeping sickness in Uganda, has left for England on the conclusion of his mission. Lieut.-Col. Bruce is reported to have stated that the ravages of the disease are unabated.

ACCORDING to a telegram from New York, through Laffan's Agency, Mr. W. G. Tight, the president of the University of New Mexico, has made the ascent of Mount Orata, in Bolivia. This is the first time the peak has been scaled.

THE members of the Liverpool School of Tropical Medicine trypanosoma expedition to the Congo Free State (Drs. Dutton, Todd, and Christy) started on Friday last from Southampton.

THE next meeting of the International Congress of Hygiene will be held in Berlin in 1907. The congress has been invited to meet in Washington in 1909.

THE fourth general meeting of the American Electrochemical Society begins on Thursday next at Niagara Falls, New York, and will last for three days. The following is a list of the papers which are to be read and discussed:—"A New Type of Electrolytic Cell," P. G. Salom; "Manufacture of Ferro-alloys in the Electric Furnace," Dr. George P. Scholl; "Electrolytic Copper Refining," Dr. W. D. Bancroft; "Electro-metallurgy of Gold," Dr. W. H. Walker; "Some Theoretical Considerations of Resistance Furnaces," F. A. J. FitzGerald; "On the Supposed Electrolysis of Water Vapour," F. Austin Lidbury; "Efficiency of the Nickel Plating Tank," Prof. O. W. Brown; "Electrolysis of Sodium Hydroxide by Alternating Current," Carl Hambuechen; "A Practical Utilisation of the Passive State of Iron," Prof. C. F. Burgess; "The Present Status of the Theory of Electrolytic Dissociation," Dr. E. F. Roeber; "Berthelot's Law of Electrochemical Action," C. J. Reed. There will also be a discussion on the theory of electrolytic dissociation.

THE thirteenth annual convention of the American Electro-Therapeutic Association will take place at Atlantic City, New Jersey, from September 22 to 24. A lengthy programme of interesting papers which are to be read at the gathering has been published.

AN educational exhibition of edible fungi is to be held under the auspices of the Royal Horticultural Society in the Drill Hall, Buckingham Gate, on September 15. A lecture on the subject of the exhibition will be given in the afternoon by Dr. M. C. Cooke. All interested in extending or acquiring the knowledge of the edible species are invited to send specimens, but notice of an intention to exhibit should, if possible, be sent a few days before to the secretary of the Royal Horticultural Society.

AT the International Congress of Hygiene which has just been held in Brussels the following resolution was passed on the motion of Sir Patrick Manson:—"That this congress, recognising the practical importance of the mosquito malaria theory, would urge on all Governments in malarial countries (1) that officials, both civil and military, be required before taking service in such countries to show evidence of practical knowledge of the theory and its application; (2) that educational establishments, whether governmental, missionary, or other, in such countries be requested to include in their curriculum instruction of native students in the mosquito malaria theory and its practical application; (3) that officials ignorant of the theory or systematically ignoring its practical application be considered as unsuitable for service in malarial countries." In addition to the foregoing resolution the first and second sections of the congress sitting together passed the following resolution:—"That human tuberculosis is perfectly transmissible from one person to another. Nevertheless, in the present state of our knowledge, it is necessary to recommend hygienic measures for the prevention of the propagation of animal tuberculosis in the human species."

THE Scottish Sanitary Congress was opened at Stranraer on Thursday last, when the president, Prof. Glaister, of Glasgow University, delivered an address, and various papers dealing with sanitary matters were read and discussed. Prof. Glaister, in the course of his remarks, urged that men of science and local authorities should realise the detrimental effect of atmospheric pollution, and together grapple with the subject. The prejudicial effects of town living could not be better demonstrated than in the depreciated physique of the third and fourth generations of many of those who had proceeded from the country to the towns. One of the significant features of present-day statistics, and one calling for the serious consideration of sanitarians, was the high prevailing rate of infantile mortality in populous centres. If the state of the principal English towns for 1901 be considered, it will be found that the infantile death rate varied from 126 per thousand up to 226 per thousand. These figures exhibited a great wastage of infantile life. He affirmed that it was a preventable wastage, and, therefore, worthy the reflections of sanitarians. Such high rates of infantile mortality were bound in the future to become a serious national concern in view of the diminution of the birth rate which had been progressively taking place for the last few decades.

THE fourteenth annual meeting of the Institution of Mining Engineers was held last week in Nottingham under the presidency of Mr. J. C. Cadman. The Institution appears from the report to be in a satisfactory condition, the membership being at present more numerous than at any former period. The present total is 2601 as compared with 2554 of the previous year.

THE Municipal Exhibition at Dresden has been a great success. In all, 128 German communities, including practically the whole of the large cities, contributed officially to it. The exhibition was of a practical nature, and provided a more or less complete survey of municipal achievement, effort, and ideals. It was divided into eight sections, which again were subdivided. The regulation of traffic, lighting, the police and police-courts, ordinary and model dwelling houses, public art galleries, public health, school accommodation and buildings, public education, the care of the poor and the sick, benevolent institutions and charity schools, the financial administration of municipalities, infectious and common diseases and their prevention and cure, safeguards against fire, parks and open spaces, and the growth of towns were among the numerous features of municipal life illustrated.

SHORTLY before his death, the late Prof. Nocard, of Paris, strongly urged the authorities of the Liverpool School of Tropical Medicine to make the institution available for the instruction of veterinary surgeons. A committee has now been formed for the purpose of giving effect to this suggestion, and the veterinary branch is open for the reception and instruction of students. It is under the direction of Profs. Boyce and Sherrington, with adequate assistance, and a farm has been provided at Runcorn for its requirements.

THE Tramways and Light Railways Association offers an annual prize, consisting of a bronze medal and books, for the best essay on improved means of communication. No essay must exceed 4000 words in length, and the right is reserved by the council to publish the papers in the Association's official journal.

A GRANT of 70,000 r. (7000*l.*) has been made to the Moscow University by the Russian Government for the purpose of technical education; of this sum 30,000 r. is allocated to a

physical institute, 15,000 r. to a chemical laboratory, and the balance to physico-geographical, zoological, and botanical teaching.

A NEW gem, lilac coloured and transparent, has recently been discovered in California by Dr. George F. Kunz, of New York. On the suggestion of Dr. C. Baskerville, of the University of North Carolina, who made an analysis of the mineral at the New York Museum of Natural History, the name of Kunzite has, it is stated, been given to the stone in honour of its discoverer. In the course of the tests made by Dr. Baskerville, the Kunzite crystals were subjected to the action of ultra-violet light without showing any evidence of fluorescence or phosphorescence, and it was not until Röntgen rays of very high penetration were brought to bear upon them that they became at all fluorescent. On their removal to a dark chamber they exhibited a persistent white luminosity never before observed in this class of minerals. A description of the gem, by Dr. Kunz, appears in *Science* of August 28.

THE *Pioneer Mail*, Allahabad, states that the Ceylon Government has given notice that, under the Insect Pest Ordinance, the importation of pepper plants into Ceylon from any part of India is prohibited. The dried seed of the pepper plant imported for commercial use is, however, exempt from the prohibition.

THE daily weather report issued by the Meteorological Office on Friday last, September 4, showed that a barometric depression had passed the Azores and was advancing on an easterly course; the mercury was lowest on the west coast of Ireland, with south-easterly winds, and the air becoming close and thundery. As occasionally happens, a secondary depression was developed to the southward of the primary system, and this subsidiary disturbance caused during the afternoon severe thunderstorms over the southern portion of England, which subsequently extended to the metropolis and eastern coast, accompanied by torrential rain, laying many districts under water. At Ventnor a fall of 1·65 inches was recorded the next morning, at Westbourne 2·4 inches, and at Brixton 1·2 inches. At some places the fall was probably greater, as at Dover the shipment of mails was delayed, and many houses in the low-lying districts of that town were flooded to the depth of several feet.

PROF. LANGLEY has addressed a statement to the American Press with reference to his mechanical flight experiments from which we abstract the following:—"These trials, with some already conducted with steam-driven flying machines, are believed to be the first in the history of invention where bodies far heavier than the air itself have been sustained in the air for more than a few seconds by purely mechanical means. In my previous trials success has only been reached after initial failures, which alone have taught the way to it, and I know no reason why prospective trials should be an exception. . . . The fullest publicity consistent with the national interest (since these recent experiments have for their object the development of a machine for war purposes) will be given to this work when it reaches a stage which warrants publication."

MR. EDISON is reported to have developed his alkaline storage battery into a form fit for commercial use, and already has works equipped capable of turning out per day one complete set of cells suitable for motor-car work; soon he will be able to turn out five sets a day. The results of tests of the practical working of the battery are said to be entirely satisfactory; four sizes are made, capable of running a car 25, 50, 75, and 100 miles respectively on one charge, at an even rate of 25 miles an hour. The possibility of working at more than normal discharge rates without injury to the cells gives cars equipped with this battery good hill-climbing powers. The results of general outside experience of the battery will be eagerly awaited.

MR. MARCONI, who recently went out to America on board the *Lucania*, had special apparatus fitted on the ship to enable him to carry out experiments during the voyage. The main object of the experiments was to determine the power necessary to transmit messages to and from a moving station, such as a ship, with varying distances.

IT is announced that the Metropolitan District Railway will be equipped with trains run on the multiple unit train control, which is in use on the Central London and several American railways. Each train will have three motor-cars all controlled by a single driver; if by any accident the driver is incapacitated, the train is automatically brought to a standstill as soon as he releases his hold on the driving lever. The motor equipment is separated from the public part of the car by a fireproof steel partition. The contract for the equipment (known as the Sprague-Thomson Houston system) has just been placed with the British Thomson Houston Company, of Rugby and London.

THE supervision of the Imperial Department of Agriculture for the West Indies extends to several islands, where the progress that is being made is not placed on record except in the yearly reports. Of these, the report which originates from St. Vincent refers to the eruptions of Mont Soufrière during the period included in the official year 1902–3. The botanic gardens escaped, but the Georgetown experimental plot was almost entirely destroyed; even this catastrophe was turned to account, as experiments were started in order to test the possibility of growing certain plants, such as sugar-canes, cotton, ground-nuts, &c., in the volcanic ash. The experiment station of the British Virginia Islands is situated at Tortola, and the yearly report is presented by Mr. Fishlock, who took up the position of agricultural instructor at the beginning of the year. The station lies low, and is not suited to the cultivation of cacao or coffee, but pines produce excellent crops, and there is every reason to expect that good results will attend the introduction of cotton cultivation.

A PAPER entitled "The Forward Movement in Plant-breeding" was read by Prof. L. H. Bailey before the American Philosophical Society, and is published in its *Proceedings*. The advice which is offered to the scientific breeder is to get thoroughly acquainted with the characteristics and qualities of the plant which it is desired to cultivate, to decide in what direction he can make practical improvements, and after choosing what appears to be a suitable strain, to get all the information possible from his results by means of a careful system of measurement and tabulation.

IN the September issue of the *Irish Naturalist* Messrs. Carpenter and Beresford publish the result of certain experiments as to the relations existing between the wasps respectively known as *Vespa austriaca* and *V. rufa*. The former, which is not uncommon in Ireland, is believed to produce no workers, but to breed as an "inquiline" in the nests of other species. In a nest with an *austriaca* queen kept under observation by the authors, all the workers hatched were of the *rufa* type, while of the drones some were *austriaca*, some *rufa*, and others intermediate between the two. As the two forms are sufficiently distinct to be regarded as species, it seems as if we had here an instance of the origin of species by discontinuous variation. "We

think that we see here a new species arise by the production, through many generations, of an increasing number of individuals (*rufa* forms) among the offspring, that are markedly unlike the parents (*austriaca* forms). We believe that *austriaca* forms give rise to *rufa* forms, but we have no evidence of the reverse process."

AT the conclusion of the second part of his memoir on the development of the molluscan lingual ribbon, or radula, Mr. H. Schnabel, in the *Zeitschrift für wissenschaftliche Zoologie*, vol. lxxiv. part iv., points out an important distinction in this between cephalopods and gastropods. In contrast to the cephalopods, the development of the radula in the gastropods commences, not with the appearance of the single unpaired median row of teeth, but with a number of paired lateral rows. The other contents of the issue include an article on gastrulation in Cucullanus, by E. Martini; an essay on the morphology of the male genital appendages of the Lepidoptera, by E. Zander; and an account of the structure of the bristles in certain chætopods and brachiopods, by A. Schepotieff.

THE alleged occurrence of "aptosochromatism," that is, colour-change in feathers without moulting, in birds, has by no means met with universal acceptation, one at least of the late Mr. F. J. Birtwell's three papers on this subject having been adversely criticised. Shortly before his death Mr. Birtwell entered on a fresh series of observations in the hope of establishing his theory on a basis which would be beyond question. These observations, which were made on two species of buzzard, are now published in the *Bulletin* of the Hadley Laboratory of the University of New Mexico (vol. iii. No. 7).

AN Irish specimen of Dopplerite has been described by Mr. Richard J. Moss (*Sci. Proc.* Royal Dublin Soc., vol. x. No. 6). It was found in peat in Sluggan bog, at Drumsue, near Cookstown Junction, in County Antrim. In its original moist condition it appeared like a stiff jelly of a velvety-black colour, but when dry it became very like jet, breaking with a conchoidal fracture, and exhibiting a vitreous lustre. Dopplerite was originally found in peat in Styria, and has not previously been recorded from Britain. It appears to have been formed from peat by a process of oxidation.

A HANDBOOK to Southport, which should prove of much service to those attending the meeting who are not well acquainted with the town, has been written for the members of the British Association. Southport is considered from a historical and descriptive point of view, and as a health resort. Other chapters are devoted to meteorology, geology, botany, zoology, Martin Mere, archæology, and the life and works of the Rev. Jeremiah Horrocks (spelt in the volume Horrox). The volume is published by Messrs. Fortune and Chant, of Southport, and appears to have been carefully prepared.

THE current issue of the *Illustrated Scientific News* is a double one, and brings to a close our contemporary's first volume. The number contains many interesting articles, among which there are no fewer than three respecting the British Association; one is illustrated by portraits of the president and five of the presidents of sections for this year. Other contributions deal with "Charlottenburg," the "Solar Physics Observatory at Meudon," "Progress with Airships," &c.

THE additions to the Zoological Society's Gardens during the past week include two Black Rats (*Mus rattus*), British, presented by Mr. J. E. Millais; a Ducorps's Cockatoo (*Cacatua ducorpsi*) from the Solomon Islands, presented by Mrs. J. Aarons; a Neumann's Baboon (*Papio neumanni*), a Doguera Baboon (*Papio doguera*) from Abyssinia, a Bell's Cinixys (*Cinixys belliana*) from Tropical Africa, an Adanson's Sternothere (*Sternothoerus adansoni*) from North-east Africa, deposited; three Fat-tailed Desert Mice (*Pachuromys dupresi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SEARCH-EPHEMERIS FOR FAYE'S COMET.—In No. 3896 of the *Astronomische Nachrichten*, Herr E. Strömgren gives a continuation of the search-ephemeris for Faye's comet which appeared in No. 3876 of the same periodical, and was reproduced in these columns. The following is an extract from the later portion:—

Ephemeris 12h. (M.T. Berlin).

1903	α (h. m. s.)	δ (° ′)	log r	log Δ
Sept. 12	8 5 14	+12 13·4	0·2842	0.3864
„ 16	8 13 26	+11 34·8	—	—
„ 20	8 21 24	+10 55·5	0·2930	0·3821
„ 24	8 29 6	+10 15·5	—	—
„ 28	8 36 31	+ 9 35·1	0·3020	0·3771
Oct. 6	8 50 32	+ 8 13·4	0·3110	0·3712
„ 14	9 3 28	+ 6 51·6	0·3201	0·3645
„ 22	9 15 15	+ 5 30·7	0·3293	0·3569
„ 30	9 25 48	+ 4 11·8	0·3384	0·3484

THE CANALS ON MARS.—In the fifth report of "The Section for the Observation of Mars" (British Astronomical Association *Memoirs*, vol. xi.), several charts of the planet's surface are reproduced, in one of which, Plate viii., the director of the section, M. E. M. Antoniadi, has omitted the reticulated canal systems so familiar to aërographers on the charts published during the last twenty-five years. These have been omitted because recent research has thrown grave doubts on their objective reality.

In the recent experiments carried out by Messrs. Maunder and Lane it was demonstrated that the regular "canaliform" markings may be consistently seen by numerous unbiased individuals on a surface which is free from any such markings, but which has drawn on it features similar to the other markings on Mars. It was also pointed out that, in general, the so-called canals on aërographical maps are drawn either from one projecting feature to another or where half-tone boundaries are seen on the planet, just where one would expect them to be drawn if they were really due to physiological suggestion.

Many so-called "canals" are retained on M. Antoniadi's chart, but these are not of the rigidly geometrical shape shown on the charts published during recent years, and are, probably, objective features of the Martian landscape (the *Observatory*, No. 335).

RADIATION PRESSURE AND COMETARY THEORY.—In No. 5, vol. xvii., of the *Astrophysical Journal*, Messrs. E. F. Nicholls and G. F. Hull describe and illustrate some laboratory experiments they have made at Dartmouth College, Hanover, U.S.A., in order to demonstrate the effect of the solar radiation pressure in the formation of comets' tails.

A glass tube shaped like an hour-glass was partially filled with sand and dried lycopodium powder, and then highly evacuated. On causing the sand and powder to fall from the upper to the lower part of the tube, and directing an intense beam of light against the stream, it was seen that, whilst the sand fell vertically, the powder was diverted in the direction of the beam against the side of the tube opposite to the light source. Unfortunately the light pressure, on particles of the size and density used, had been previously overestimated, and a subsequent calculation showed that the observed deviation may not have been wholly due to the light-pressure, although some of it was.

Another suggestion as to the cause of repulsion in cometary phenomena is that the particles heated from one side evolve gases, and are, therefore, driven in the opposite

direction in a similar manner to the ordinary rocket, and in the experiments performed by Messrs. Nicholls and Hull this "reaction" pressure would be about ten times as great as the "radiation" pressure. This research has experimentally illustrated the repulsion, and has shown that a part of it at least is probably due to the "radiation" pressure; it now remains to determine more definitely the relative effect of each of the possible causes.

A CATALOGUE OF 1520 BRIGHT STARS.—As the "Revised Harvard Photometry," which will contain details of about nine thousand stars of magnitude 6·5 and brighter, is not yet ready, the Harvard College Observatory has published a smaller catalogue, which only contains 1520 stars, and does not give the detailed information which will be contained in the larger volume.

The catalogue gives, in tabular form, the H.P. number, the constellation name, the R.A. and declination, the magnitude and the type of spectrum for each star, and a comprehensive set of "remarks" describes the peculiarities appertaining to various stars included in the list.

A large edition of the catalogue has been prepared, and anyone interested may obtain a copy on applying to the director.

IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute was held in the Town Hall, Barrow-in-Furness, on September 1, 2, and 3, with Mr. Andrew Carnegie, the president, in the chair, and was very largely attended. After an eloquent address of welcome from the Mayor, Mr. Carnegie delivered a short presidential address, in which he traced the progress made in the metallurgy of iron and steel since the Institute's last visit to Barrow twenty-nine years ago. After various business announcements had been made by the secretary, Mr. Bennett H. Brough, the reading and discussion of the thirteen papers on the programme began. The first read was that by Mr. R. A. Hadfield on the alloys of iron and tungsten. This formed a monograph of sixty-eight closely printed pages. It contains historical details regarding the ores of tungsten, the metal and its alloys, and a large amount of physical data. It concludes with a carefully compiled bibliography of the subject, showing that a large amount of attention has been devoted to studies of this interesting metal and its employment in the manufacture of steel. Osmond, by his cooling curves, has brought out several peculiar points in the thermal behaviour of this steel, and Barrett has discovered that tungsten affects the conductivity of iron less than any other added element. Though tungsten-iron alloys will have an important future, there is no doubt that their use is not likely to be on the same large scale as some of the other special steels now produced. In the discussion some interesting details were added by Mr. F. W. Harbord and by Mr. J. E. Stead.

This paper was followed by a series of memoirs dealing with the heat treatment of steel. These were discussed together.

The paper read by Mr. J. E. Stead and Mr. Arthur W. Richards on the restoration of dangerously crystalline steel by heat treatment established facts of far-reaching importance. The microscope shows that heating at high temperatures causes a great development in the size of the crystalline grains, and reheating to about 870° restores the original or a better structure. If all structural steels in their normal rolled or forged condition are good, they can be readily deteriorated in quality by heating to a temperature a little above that to which steel is most commonly heated previous to rolling or forging. Steel made brittle by such heating, and dangerously brittle by heating at considerably higher temperatures, can be completely restored to the best possible condition without forging down to a smaller size or by remelting. Not only are the original good qualities of normally rolled steel, after making brittle, restored by the exceedingly simple treatment of heating to about 900° C. for a very short time, but such steel is made considerably better than it was. That brittle "soft steel" can be restored by reheating is well known, but that carbon steels can be actually made much superior to the original properly forged metal by reheating to 870° and cooling in air is a discovery. It is urged that in every large forge and smith's shop Le Chatelier pyrometers should be introduced, together with suitable furnaces for reheating the forgings.

Mr. J. E. Stead and Mr. Arthur W. Richards next read a remarkable paper on sorbitic steel rails. The term sorbitic is used for a transition condition of the carbide intermediate between the states in which it exists in hardened and annealed steels. The chief point of interest in the authors' work is the simple method employed for producing sorbite in steel. The usual custom has been to reheat and oil-harden, or to quench completely in water and reheat to dull redness. They avoid reheating, and quench the heads of the rails, and allow the residual heat in the rails to do the tempering. The results of the later experiments show clearly enough that by partially quenching the heads and allowing the rails to temper themselves, although the elongation is decreased, the contraction of area remains practically the same. A normal rail of 37 tons tenacity when made sorbitic is increased in strength to 45 tons without diminution of the contraction of area. A normal rail with $36\frac{1}{2}$ tons tenacity is increased to 49 tons with a slight increase in the contraction of area. In other cases the tenacity is increased from 43 to 50 tons with a slight diminution in the contraction of the area. Pieces of the rail cut from the area of maximum sorbite on being tested by repeated reversals of strain showed greater toughness and endurance than the normal material. The wear is very greatly in favour of the sorbitic material, as would naturally be expected, and it is believed that, by treating the rails in the simple manner described, their life will be increased from 25 to 50 per cent. The results obtained should lead metallurgists to aim at replacing pearlite by sorbite in all structural steels that have to be subjected to friction, percussion, or vibration when in use.

A paper on the heat treatment of steel rails high in manganese was contributed by Mr. J. S. Lloyd (South Russia). Steels containing more than 1 per cent. of manganese have not hitherto been fully studied, and a research carried out in Russia by the author shows that, at the ordinary normal heat suitable for rolling ingots, steel containing 0·46 per cent. of carbon and 1·33 per cent. of manganese is made exceedingly brittle if it is not further treated, but is allowed to cool on the mill floor. Slowly cooling in the furnace after heating for eighteen hours at 950° makes the material about twice as ductile as it was in the original rail, but the tenacity is considerably reduced. The heating to the rolling temperature causes an enormous development in the size of the crystals, but these are broken up and become about one-eighth of the dimensions by heating to 950° C. and slowly cooling afterwards, and the structure so obtained is twice as fine as it was in the normal rail.

Some further experiments on the diffusion of sulphides through steel were described by Prof. E. D. Campbell, of the University of Michigan. They appear to sustain the conclusions drawn from his work—that iron is permeable by sulphides when heated above 1200° C., and that the sulphur content of the iron is not necessarily increased by the passage of the sulphide through it. In fact, in a slightly oxidising atmosphere the sulphur content of the steel may be even less after the diffusion than it was before. The author is not prepared at present, from the experimental data at hand, to give a positive explanation of the manner in which sulphides permeate or diffuse through iron. The most plausible hypothesis would seem to be that the sulphides originally present in the iron fill more or less completely the interstitial spaces between the crystals of iron; that above 1200° these sulphides are very fluid, and may be drawn out of the steel by capillary action of some absorbent such as asbestos, and their place taken by some other sulphides, provided these latter are sufficiently mobile to find their way into the extremely minute spaces between the steel crystals. If the sulphide replacing the original sulphide contain less sulphur than the latter, or if absorption by the asbestos continued after the sulphides had ceased to enter the iron from within, the diminished percentage of sulphur in the steel at the hot end would be readily accounted for.

The paper by Prof. A. Stansfield on the overheating and burning of steel was a report on work carried out by him

as Carnegie research scholar, its publication having been delayed by his appointment to the chair of metallurgy at Montreal. The memoir covers thirty-six pages. The burnt structure of very much overheated steel is shown to be largely due to the partial melting which results from heating the steel above a given temperature. This melting causes brittleness directly, and indirectly by the admission of oxygen to the steel. According to American metallurgists the latter stage would alone be called burning, but as the effect of partly melting the steel is quite distinct from that of overheating below the zone of partial fusion, the author would prefer to apply one word to the whole of the changes that take place in this zone. If the word burning is still employed, it should be remembered that it is essentially a partial melting of the steel, though often accompanied by oxidation. The following stages have been recognised:—(1) overheating (below the point of incipient fusion); (2) partial melting, called burning; (*a*) merely producing segregation of carbon in the joints; (*b*) accompanied with liquation and producing flaws; (*c*) further liquation and oxidation in the flaws. (1) Steel that has merely been overheated can be completely restored by heating just above its highest recalescence point and allowing to cool. (2) Steel in the stage (*a*) can be restored by suitable annealing; in the stage (*b*) forging would also be needed; and in stage (*c*) it would be restored with great difficulty, if at all.

The paper on the heat treatment of steel submitted by Dr. William Campbell (New York) is a report on research carried out by the author as Carnegie research scholar. It forms a pamphlet of ninety-three pages. The steel used contained 0·50 per cent. of carbon, 0·98 manganese, 0·094 silicon, 0·098 phosphorus, and 0·08 sulphur. The structure of the steel used was found to depend upon the two constituents present, namely, the ferrite and the pearlite. The pearlite will certainly show the finest structure when the steel has been heated to just above Ac_1, or when it has been transformed into martensite. Heating to temperatures above this point will cause a coarsening of the structure. The higher the temperature the coarser the structure. Above Ac_1 the ferrite begins to diminish in size, due to its being dissolved in the martensite. This will continue until the whole of it is dissolved, when the change Ac_{2-3} is complete. Then the finest structure of the whole will be found where these two changes balance. This point is apparently just below the point where Ac_{2-3} is complete. The best finishing temperature is such that the bars leave the rolls as near Ar_{2-3} as possible. The bars would necessarily have to be drawn from the furnace at a higher temperature, which is about 740° C. in this case, allowing for a cooling of, say, 40° C. or more during rolling. In comparing the results obtained with those of pure carbon steel, the effect of the manganese present must be taken into consideration.

An animated discussion followed the reading of these papers on heat treatment, in which Messrs. Westgarth, Ridsdale, Lange, Price-Williams, L. N. Ledingham, and Hadfield took part.

The probability of iron ore lying below the sands of the Duddon Estuary formed the subject of a paper by Mr. J. L. Shaw (Whitehaven). He adduces evidence to show that there is a limestone area probably carrying large bodies of ore, and advocates the putting down of exploratory boreholes. In the discussion Mr. G. J. Snelus gave further particulars of geological interest.

The paper by Mr. W. F. Pettigrew on coal as fuel at Barrow-in-Furness contained much of interest. In that district at the present time coal is obtained from Cumberland, Lancashire, and Yorkshire. As the prices at the pit, the cost of carriage, and the quality of the coal from these districts vary considerably, the author has carried out several experiments to find the relative value of coal obtained from the districts before mentioned, also from various parts of Scotland and South Wales. Experiments carried out with a locomotive showed that the sample of Yorkshire No. 1 gave the best results. This coal has excellent steaming qualities, is very clean, with an open clinker, and low percentage of ash. The Welsh coal was also good when tried, and equal in all respects to the Yorkshire coal, and would no doubt give even better results if properly fired, which was not the case during the trials, the men having had practically no experience with this kind of coal. The Cumberland coal was good, particularly one sample, but this was not found suitable for locomotive purposes. The other sample of Cumberland coal gave fairly good results, but it is a dirty coal, and necessitates the frequent cleaning of fires. The Lancashire samples were in some cases very good steaming coal, with a moderately low consumption, but several samples gave very bad results, and were quite unfit for locomotive purposes. The Scotch coals tested were fairly good, but in most cases a very heavy consumption was recorded. They are quick burning coal and dirty, but with an open clinker, which did not interfere in any way with the steaming. The consumption was from 20 to 40 per cent. higher than the Yorkshire coal.

Mr. C. H. Ridsdale (Middlesbrough) read a lengthy paper on the diseases of steel. In it he collated various types of defects, and traced them to their origin.

Mr. H. Ehrhardt, of Dusseldorf, contributed a paper describing a process for making weldless steel pipes and shells by which rings up to 8 feet in diameter and 10 feet in length are manufactured.

The regulation of the combustion and distribution of the temperature in coke oven practice was dealt with in a paper by Mr. D. A. Louis. Illustrations were given to show the design and character of the Brunck and v. Bauer coke ovens, two ovens of new design.

The influence of silicon on iron was dealt with in a paper by Mr. Thomas Baker. He prepared a series of alloys of silicon and iron with traces only of other elements, and studied the micro-structure and physical properties of each. Although the addition of silicon to iron increases the elastic limit and tenacity of iron, such increase is only obtained by loss of ductility, which loss, provided the material has been well annealed, is very small until the silicon reaches 3 per cent., after which it becomes very great, the ductility almost becoming zero with 4 per cent. silicon. The alloys gradually increase in hardness with the addition of silicon, and after exceeding 5 per cent. silicon require great skill and care in machining in order to avoid fracture of the bar. As the percentage of silicon increases the permeability for low magnetic fields increases, and the coercive force and hysteresis loss decrease. Prof. T. Turner (Birmingham) was the chief speaker in the discussion.

The proceedings concluded with the customary votes of thanks to the reception committee, and an invitation, tendered by Mr. Kirchhoff, of New York, on behalf of the American societies, that the Institute should meet in the United States next autumn was accepted.

In connection with the meeting an elaborate programme of visits and excursions was arranged, including the works of the Barrow Hæmatite Steel Co., the Askham blast furnaces, the Hodbarrow mines and sea-wall, the naval construction works of Vickers, Sons and Maxim, the Furness Railway locomotive works, the North Lonsdale iron works, and to Lake Windermere, Grasmere, and Blackpool. The social functions included a conversazione given by the Mayor, a ball by the reception committee, a garden party by Mr. Victor Cavendish at Holker Hall, and an illuminated *fête* at Furness Abbey.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SATURDAY, October 31, has been fixed for the holding of a convocation of the University of Oxford for the purpose of electing a Chancellor of the University in the place of the late Marquis of Salisbury.

ARRANGEMENTS for next term have been published in connection with the Oxford University School of Geography. Nine lectures a week by different members of the staff will be given in various branches of geographical science, and practical instruction to supplement several of the courses of lectures has been arranged. A geographical scholarship of the value of sixty pounds is to be competed for on October 14, and candidates must have taken honours in one of the final schools of the university. Courses of instruction are now given also in preparation for the university certificate in surveying, and to meet the requirements of students reading for the university diploma in education.

THE report of the Board of Education for 1902–3 shows that during the session 1901–2 the total number of students receiving science and art instruction under the Board was 291,758. The total number of schools in which the teaching was given was 2061. The grants paid during the year amounted to 314,212*l*., of which 143,671*l*. was paid upon attendances. From the same report we learn that great progress has been made with the new buildings for the Royal College of Science. It is hoped the work will be complete in two years' time.

THE University College at Reading continues its useful work in the adjoining counties in connection with field trials and lectures at rural centres, and the work of the agricultural department is of a kind to secure the confidence of practical men. Instruction in dairy farming and dairying is given in cooperation with the British Dairy Institute; the College Poultry Farm at Theale is available for students who desire to obtain a practical acquaintance with poultry-keeping; and there is a college garden for horticultural practice and instruction.

AT the forthcoming opening of the medical schools, the following will deliver addresses:—At the St. George's Hospital medical school on October 1, Dr. W. R. Dakin; at King's College, London, on October 1, Sir John Alexander Cockburn, K.C.M.G., on "Imperial Federation and its Physiological Parallels"; at Guy's Hospital Physical Society, on October 10, Dr. J. F. Goodhart; at the Middlesex Hospital on October 1, Mr. William Hern; at the Medical Faculty of University College, London, on October 5, Prof. E. H. Starling, F.R.S.; at the University of Liverpool on October 1, Sir Dyce Duckworth; and at the University College, Sheffield, on October 15, Sir Michael Foster, K.C.B., F.R.S.

THE report on the work of the Sir John Cass Technical Institute for the session ending last July, and the recently published syllabus of the classes to be held during next winter together show that this young polytechnic is doing excellent work. Many of the students are engaged in technical pursuits during the day. For example, quite half of the students of chemistry are employed in some form of chemical technology, and an examination of the entries of last winter in the metallurgical department shows that one was the head of a firm of bullion refiners, three were managers in metal refining works, five were chemists engaged in metallurgical industries, three were foremen in metallurgical works, and others clerks or samplers in works or trades associated with metals. Among others of a thoroughly practical nature arranged for next session may be noticed a course of practical instruction in glass blowing suited to the requirements of chemists, physicists, teachers, and those engaged in the making of glass apparatus and instruments.

IN his report for the year 1903 on secondary education in Scotland, Sir Henry Craik, K.C.B., says there has again been a gratifying increase in the number of schools presenting candidates in science at the leaving certificate examination, and also in the total number of candidates presented. The examiners report that there is need to repeat once more the warning to teachers against taking up practical work of which the theory is beyond the comprehension of their pupils, or has not been made clear to them. The methods of examination differ in some important points from those regulating the system in regard to other subjects. The examination is chiefly oral and practical, and it is shaped in the case of each school by the curriculum of that school. It is interesting to find that the most satisfactory work appears to be done in the schools the profession of which is comparatively modest. In practical science, as in all educational subjects, the special discipline given is better got from a thorough study of one branch than through a too ambitious attempt to cover a very wide field. The chief examiner is inclined to recommend that, unless the time available during the third year's course is more than four hours a week, the whole of it should be devoted to one subject instead of being divided between two. Another point to which he directs attention is the very limited extent to which "home-made" apparatus is employed in the laboratories.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 31.—M. Bouquet de la Grye in the chair.—A fixing liquid isotonic with sea water, for objects in which it is desired to preserve lime formations, by M. M. C. **Dekhuyzen**. In a previous note a formula has been given for a liquid, isotonic with sea water, for fixing delicate marine organisms. This contains acid, and in fixing the larvæ of sea urchins, which contain extremely delicate chalk formations, it is necessary to employ a liquid free from acidity. The formula of a liquid possessing the required properties is given in the present paper, and in the hands of M. Delage has given perfect results in fixing very delicate larvæ.

GOTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iii. for 1903, contains the following memoirs communicated to the society:—

February 21.—W. **Voigt**: Questions of crystalline physics, i. On the rotatory constants of heat-conduction in apatite and dolomite.

March 7.—W. **Kaufmann**: On the "electromagnetic mass" of the electrons. V. **Cuomo**: Measurements of the electric dispersion in the open air at Capri (October, 1902–February, 1903).

May 16.—W. **Voigt**: On the theory of total reflexion. K. **Schwarzschild**: Contributions to electrodynamics—(1) two forms of the principle of least action in the theory of electrons; (2) the elementary electrodynamic force.

June 13.—F. **Merkel**: Remarks on the fasciæ and veins of the human pelvis.

The "Business Communications," part i. for 1903, contain a report on the Samoa Observatory, and a highly appreciative obituary notice of the late Sir G. G. Stokes, by Prof. W. Voigt.

CONTENTS.

THURSDAY, SEPTEMBER 17, 1903.

THE WORTH OF EXPERIMENTAL PSYCHOLOGY.

Experimental Psychology and its Bearing on Culture. By George Malcolm Stratton, M.A., Ph.D. Pp. vi + 331. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 8*s.* 6*d.* net.

THE aim of this well written and interesting book, we are informed, is "to present . . . the character and value of the laboratory psychology, especially as bearing on our moral and philosophical interests. . . . Considerable attention has thus been given to the interpretation of the experimental results—to their more immediate scientific meaning, as well as to what they suggest for life and for speculation." The work, however, contains little that is really relevant to "the bearing of psychology on culture." Such topics as the value and significance of memory, suggestion and illusions, and the relation of psychology to the body and to the soul, ably as they are treated, are hardly synonymous with culture; indeed, from start to finish the object of the book is by no means evident.

It is to be regretted that Prof. Stratton did not confine himself to "the immediate scientific meaning," the range and the worth of psychological laboratory work. Once or twice this task has been already attempted in our language, but it has not yet been satisfactorily performed. The need for such a work has never been greater than now, when the number of psychological laboratories and their workers is multiplying rapidly, while physicists and physiologists are for the most part ignorant of, and hence are prone to ignore and to condemn, the aims and methods of experimental psychology. To this class of readers the present work is not well suited, and will hardly carry conviction. It appeals more to an educated public, which prefers to nibble at the significance of experimental psychology, and to swallow certain inevitable crudities of statement, rather than to digest the subject with proper care. The ground covered by the book is too vast, and departures from purely experimental topics are too often and too far made to allow of a really accurate and critical exposition. For this reason, no doubt, the author has made little attempt to exhibit the various themes of experimental study in their proper perspective. He has been forced to neglect some of the most important advances in purely psychological method, *e.g.* the work of G. E. Müller and his Göttingen school, and the genetic and comparative sides of experimental psychology; while undue space is given to some trivial experiments in æsthetics that have scant meaning or interest, and a few others are made to bear interpretations which are far from being justified in fact.

"Some recent experiments by Dunlap," says the author (pp. 88, 89), "show that lines, so drawn as to produce an illusion of distance [*i.e.*, the angle-forming lines in the well-known illusion of Müller-Lyer], may influence our estimate of space even when these lines are quite imperceptible."

Reference, however, to the statistical results of the original paper and to its writer's own convictions shows that this conclusion is by no means so certain. The author uses these and other considerations in his chapters on the evidence for unconscious ideas. He ends with the statement (p. 92) that

"the results are not in favour of unconscious ideas, but rather of certain unconscious materials out of which conscious ideas arise."

One is tempted to ask how he can be sure, if the "materials" are unconscious, that they *are* "materials" and not "ideas." His psychological treatment of poetical rhythm is not convincing, the subject being too complex to tolerate an acrobatic arithmetic which connects all measures with "the pulse-time of attention." Probably the latter bears about the same relation to our appreciation of rhythm as our range of hearing to the enjoyment of a Beethoven symphony. Nor is it the whole truth, albeit the fashion to say (p. 269) that "what goes on in our minds never is really there until it is expressed," and that "in all manner of mental action there is some physical expression."

The chapters on the general character of psychological experiments, on imitation and suggestion, on illusions, and on the spatial perceptions of the blind, are quite ably and entertainingly written. The author's classification of illusions leads to curious results. He groups the illusion, in which a large box is judged lighter than a smaller box of equal weight, in the same class with the two fundamentally different illusions, in which truly isochronous intervals are subjectively resolved into rhythmic series, and in which a space of time filled with sounds is adjudged of different length from an equal but "empty" space of time. This class of illusions is said to arise "from stress of attention"! We are told also (p. 106) that within this class "the symbols themselves do not seem to be misinterpreted, they have been distorted . . . by our mental states." Elsewhere the author admits that *all* illusions "involve a misinterpretation."

But sufficient has been said to give a general notion of the faults and virtues of this book. In broad principles there is little to which the psychologist can take exception. Its style and language appear to be excellently suited to its readers, and the author has an adequately wide grasp of his subject. If he has failed in his task, the reason is because he has attempted too much. For to treat of the problem, which he has set himself, in three hundred or more pages is as impossible as it is to do justice to his bold endeavour within the compass of this review.

C. S. MYERS.

HYDRAULICS.

Treatise on Hydraulics. By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. Eighth Edition, Rewritten and Enlarged. Pp. viii + 585. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 21*s.* net.

THIS book bears the same title, has practically the same number of pages, and is published by the same firms, as a book by Prof. Bovey, of McGill University, Montreal, which appeared in 1901, and was reviewed in these columns in February last year.

Though, however, the present book, like its predecessor, is intended primarily for students in colleges and technical schools, and secondly for engineers, and one or more problems, intended to be solved by the reader, are appended at the end of each article, relating to the special subject treated of in the article, it deals with the various hydraulic principles and problems successively investigated in a more simple manner than the former book, which is calculated to commend it to the favourable notice of practical engineers, too engrossed in their work to be able to spare the time for fully grasping abstruse mathematical considerations.

The book is divided into sixteen chapters, and is further subdivided into one hundred and ninety-two articles, each numbered, and dealing with a subject under a special heading connected with the general purpose of the chapter which contains it; whilst an appendix at the end, occupying forty-three pages, after pointing out certain analogies between the flow of water in pipes and the passage of the electric current along wires, and adding some miscellaneous problems for solution, furnishes fifty-five useful hydraulic and mathematical tables, the former being given both in English and in metric measures.

The first four chapters treat successively of "Fundamental Data," "Hydrostatics," "Theoretical Hydraulics," and "Instruments and Observations"; whilst the following six chapters are devoted to the consideration of the various kinds of flow, namely, through orifices, over weirs, through tubes, through pipes, in conduits, and the flow of rivers. The remaining six chapters deal with the important practical subjects of "Water-Supply and Water-Power," "Dynamic Pressure of Water," "Water-Wheels," "Turbines," "Naval Hydromechanics," and "Pumps and Pumping." Nearly two hundred figures in the text, mostly in the form of small, simple diagrams, serve still further to elucidate the hydraulic principles so clearly and concisely enunciated; and these diagrams, instead of being numbered consecutively in the usual manner, are given the same number as the articles which they illustrate, adding *a*, *b*, *c*, &c., where more than one occur in a single article; whilst the same system of numbering is adopted for distinguishing the formulas given in the several articles, and the problems appended at the end of them. The advantage of this peculiar method of numbering is not very clear, though possibly it furnishes an excuse for omitting headings from the diagrams, and for dispensing with a list of them. By the above arrangement, however, each article, with its special number and descriptive heading, constitutes a distinct unit, in which the diagrams and formulas are merged; and whereas the chapters in the text are only headed by their special subject, the headings in the table of contents under the main headings consist merely of an enumeration of the headings of the articles in each chapter, preceded by their distinguishing numbers.

The way in which several independent articles are grouped together in the chapters to which their subjects appertain, is well illustrated by the list of articles contained in the chapter on naval hydromechanics, comprising "General Principles," "Frictional Resistance," "Work for Propulsion," "The Jet Propeller," "Paddle-Wheels," "The Screw Propeller," "Stability of a Ship," "Action of the Rudder," and "Tides and Waves." The concise and somewhat cursory manner in which the practical subjects considered in the last six chapters are touched upon, is sufficiently indicated by their taking up less than one-third of the whole contents of the book, and by such important and complex questions as water-supply and water-power being together dealt with in a single chapter of twenty-eight pages. This circumstance, however, must not be regarded as at all detracting from the merits of the book; for evidently the author is mainly concerned in laying down the principles of hydraulics, indicating the means and methods of taking observations, and establishing the laws of the flow of water under various conditions, to which subjects considerably the larger portion of the book is devoted. Then, after the principles and laws of hydraulics have been thoroughly elucidated, the methods of their application to various practical purposes, such, for instance, as water-power, water motors, propulsion, and pumping, are successively indicated, without the slightest intention on the part of the author that the brief treatment of these subjects should furnish substitutes for the standard treatises on them.

In the latter part of the book, indeed, the general features of the subjects introduced, and the action of the hydraulic machines are concisely sketched in suggestive descriptions, leaving a full investigation of the various matters touched upon to be sought elsewhere, according to the special branch on which more detailed information is required. Nevertheless, in spite of the brevity of the treatment, interesting particulars are here and there referred to, as, for example, the present utilisation of the Falls of Niagara in the development of 105,000 electrical horse-power, by means of turbines which are described, and the prospect in the near future of a largely increased use of this natural source of power; whilst it is suggested that the tides and waves afford a source of power which at present is wasted, but which, on the exhaustion of the supplies of coal, wood, and oil, may be utilised for generating power, heat, and light in unlimited quantities.

OUR BOOK SHELF.

Synthesen in der Purin- und Zuckergruppe. By Emil Fischer. Pp. 29. (Braunschweig: Friedrich Vieweg und Sohn, 1903.)

THIS lecture, delivered before the Swedish Academy at Stockholm on December 12 of last year, contains an account of Prof. Emil Fischer's work in organic synthesis, and of the motives that have guided him in attacking successively the problems of the uric acid, sugar, and more recently the albuminoid, groups of organic compounds. The synthetical methods by which the constitution of so many naturally occurring substances have been determined are described in outline only, and in a way that will appeal especially to the non-chemical reader. To the chemist the chief charm of the lecture lies in the frankness with which the lecturer describes the purpose and the ultimate goal of the work to which he has devoted himself.

Incidentally the commercial aspects of the purin syntheses are referred to. The sale of caffein and theobromine for medicinal purposes amounts to a million marks annually; at present this is all extracted from tea and cacao, but theophyllin prepared from uric acid is already on the market, and before long it may be possible to manufacture theobromine and caffein at a price that will render it possible to compete with the natural products. T. M. L.

Report on Field Experiments in Victoria, 1887–1900. By A. N. Pearson. Pp. 124; with illustrations and tables. (Melbourne, 1901.)

A RECORD of experiments on the manuring of the staple farm crops (chiefly wheat) and of fruit conducted with the cooperation of farmers at many different localities in Victoria during the ten years previous to publication. The discussion is popular in nature, and intended for the farmers of the colony. One point is very noticeable, the comparative inutility of nitrogenous manures on the soils tested and the great returns given by phosphatic dressings. A large number of results are reported, and care has been taken to analyse them and reject those vitiated by some of the many irregular factors to which field experiments are liable. The report sadly needs a digest and an index to make it useful to students of agricultural science.

THE BRITISH ASSOCIATION.

THE attendance at the Southport meeting of the British Association, while passing the numbers at Belfast last year, has fallen short of the Southport meeting of 1883 by about 1000. The weather, no doubt, is accountable for a certain diminution of numbers, for given fine weather in the middle part of last week, it is certain the figures would have reached 2000. As it is, they number 1751. Comparing this figure with those of recent meetings, however, it will be seen that a good average has been maintained, the numbers at Southport this year exceeding those at the meetings at Belfast, Dover, Toronto, Ipswich, Nottingham, and Cardiff, and falling only a little way behind the Leeds meeting of 1890. It is only when the meeting is compared with the former one at Southport that the falling off of numbers is noticeable.

On all hands the local arrangements have met with praise, the suite of rooms in the municipal buildings having proved admirably fitting for the purposes for which they were allotted.

Unfortunately, the climatic conditions during the earlier part of the meeting prevented the local arrangements being carried out to their full extent, the Mayor's reception on Thursday night taking place under most depressing conditions of rain and storm, rendering the outdoor portion of the programme an impossibility. The weather, fortunately, cleared for the excursions on Saturday, but the downpour of the previous days prevented many people from taking tickets, and many of the parties had not their full number.

The experiments in kite-flying had to be abandoned owing to various causes, and Mr. Dines has had to be content to exhibit his apparatus without taking it out to sea.

Prof. Pernter's experiments in the firing of vortex rings took place on Monday afternoon before a large number of spectators, the firing taking place from the roof of the boathouse over the North Marine Park.

The International Meteorological Committee has been sitting in the Town Hall during the meeting of the British Association, and the members were formally received by the Mayor of Southport in the Mayor's Parlour prior to the beginning of their deliberations. Opportunities have been afforded the many distinguished foreign men of science present in Southport for visiting some of the laboratories, schools, factories, and dockyards of Manchester and Liverpool.

The lecture to working men on Saturday proved very popular, the Cambridge Hall being crowded. A dinner was given by the Mayor at his residence at Greaves Hall to meet Sir Norman Lockyer and Prof. Mascart (President of the International Meteorological Committee). The guests numbered nearly 100, and included Prof. J. Dewar, A. Hopkinson (Vice-Chancellor of Victoria University), Sir George Pilkington, E. Marshall Hall, K.C., M.P., Charles Scarisbrick (Vice-Presidents), Prof. Carey Foster, Major MacMahon, Dr. Adam Paulsen, M. Teisserenc de Bort, Dr. H. Hildebrandsson, Prof. Pernter, General Rykatcheff, Dr. Hellemann, Dr. Hergesell, Dr. H. Mohn, Prof. Willis Moore, A. L. Rotch, Dr. W. N. Shaw, Dr. Ludwig Boltzmann, Dr. T. P. Lotzy, Prof. O. Lignier, Dr. M. Snellen, Dr. G. G. MacCurdy, Dr. H. C. White, T. H. Yoxall, M.P., Hon. T. E. Fuller, Monsignor Molloy, Monsignor Nugent, Canon Denton Thompson, Dr. J. G. Garson, most of the presidents, vice-presidents, and recorders of Sections, and the local secretaries and treasurer.

At the meeting of the general committee held on Friday last, the names of Profs. Mascart, Simon Newcomb, and Boltzmann were added to the list of vice-presidents of Section A.

The Hon. T. E. Fuller, Agent-General for the Cape Colony, Sir Walter Peace, Agent-General for Natal, and Mr. Fiddes, of the Colonial Office (representing the Transvaal), attended on behalf of their respective Governments for the purpose of formally inviting the Association to South Africa in 1905.

On the proposition of Prof. Dewar, seconded by Prof. H. Marshall Ward, it was decided to hold the 1905 meeting in South Africa.

On the motion of Sir Henry Roscoe, seconded by Prof. Forsyth, the Right Hon. A. J. Balfour was elected President of the meeting to be held next year in Cambridge, the meeting to begin on August 17.

The Lord Lieutenant of Cambridgeshire, the Vice-Chancellor of the University, and the Mayor of Cambridge were elected vice-presidents of the Association.

The following elections for the Cambridge meeting were made:—Local secretaries, Messrs. Ginn, A. C. Seward, G. Skinner, and Mr. A. E. L. Whitehead; local treasurers, Mr. A. E. Shipley and Mr. Parker.

Prof. Carey Foster was re-elected treasurer; Major MacMahon and Prof. Herdman general secretaries; and Dr. Garson assistant general secretary.

At the meeting of the committee of recommendations on Tuesday, the following resolutions were adopted:—

(1) That as urged by the President in his address it is desirable that scientific workers and persons interested in science be so organised that they may exert a permanent influence on public opinion in order more effectively to carry out the third object of this Association originally laid down by the founders, viz.:—"to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress," and that the council be recommended to take steps to promote such organisation.

(2) That the council be requested to consider the desirability of urging upon the Government by a deputation to the First Lord of the Treasury or other-

wise the importance of increased national provision being made for University education.

A recommendation was received from Section A referring to a suggestion from the International Meteorological Committee. At a meeting of that committee on September 11 it was decided to direct the attention of Section A to the inconveniences which arise from lack of uniformity in the units adopted in meteorological observations, and to ask it to consider if the time has not come for bringing about this uniformity. Acting upon this suggestion, the committee of Section A expressed the opinion "that the introduction of international uniformity in the units adopted for the records of meteorological observations would be of great practical advantage to science." The committee of recommendations was asked to take such steps as it may think fit toward giving effect to the above resolutions. It was decided that the matter should be sent to the council through the general committee.

It was resolved to ask the council to consider whether the form of the daily journal of the Association should not be changed so that a provisional list of arrangements for the reading of papers could be published in the journal at as early a date as possible.

The committee also decided to forward the following recommendation to the council:—

"It is desirable that further steps should be taken to make the reports (as distinguished from papers) communicated to the Association more accessible to the general public by the provision of indices to the published volumes and otherwise."

The following is a synopsis of the grants made at the meeting just concluded:—

Mathematics and Physics.

Rayleigh, Lord—Electrical Standards...Unexpended balance	
Judd, Prof. J. W.—Seismological Observations ...	£40
Shaw, Dr. W. N.—Upper Atmosphere Investigations	50 and unexpended balance
Preece, Sir W. H.—Magnetic Observations	60

Chemistry.

Roscoe, Sir H.—Wave-length Tables of Spectra ...	10
Divers, Prof. E.—Study of Hydroaromatics	25

Geology.

Marr, Mr. J. E.—Erratic Blocks...	10 and balance in hand
Scharff, Dr. R. F.—To Explore Irish Caves	Balance in hand
Watts, Prof. W.—Movements of Underground Waters	Balance in hand
Marr, Mr. J. E.—Life Zones in Carboniferous Rocks...	35
Herdman, Prof.—Fauna and Flora of the Trias ...	10
Lamplugh, Mr. G. W.—To Investigate Fossiliferous Drifts	50

Zoology.

Hickson, Prof. S. J.—Zoological Table at Naples ...	100
Woodward, Dr. H.—Index Animalium	60
Weldon, Prof.—Investigations in Development in the Frog	15
Hickson, Prof. S. J.—Researches on the Higher Crustacea	15

Economic Science and Statistics.

Cannan, Dr. E.—British and Foreign Statistics of International Trade	25

Mechanical Science.

Thornycroft, Sir J. J.—Resistance of Road Vehicles to Traction	90

Anthropology.

Evans, Sir John—Archæological and Ethnological Researches in Crete	100
Munro, Dr. R.—Researches in Glastonbury Lake Village	25
Macalister, Prof. A.—Anthropometric Investigation on Egyptian Troops	10
Evans, Dr. A. J.—Excavations on Roman Sites in Britain	25

Physiology.

Halliburton, Prof.—The State of Solution of Proteids	20
Gotch, Prof.—Metabolism of Individual Tissues ...	40

Botany.

Vines, Prof. S. H.—Completion of Monograph on Potamogeton	10
Miall, Prof. L. C.—Botanical Photographs	5
Ward, Prof. M.—Respiration of Plants	15
Ward, Prof. M.—Experimental Studies in Heredity ...	35

Corresponding Societies.

Whitaker, Mr. W.	20
	£900

SECTION A.

SUB-SECTION OF ASTRONOMY AND METEOROLOGY.

OPENING ADDRESS BY W. N. SHAW, SC.D., F.R.S., CHAIRMAN OF THE SUB-SECTION.

Methods of Meteorological Investigation.

IN opening the proceedings of the Sub-section devoted to Cosmical Physics, which we may take to be the application of the methods and results of Mathematics and Physics to problems suggested by observations of the earth, the air, or the sky, I desire permission to call your attention to some points of general interest in connection with that department which deals with the air. My justification for doing so is that this is the first occasion upon which a position in any way similar to that which I am now called upon to fill has been occupied by one whose primary obligations are meteorological. That honour I may with confidence attribute to the desire of the Council of the Association to recognise the subject so admirably represented by the distinguished men of science who have come across the seas to deliberate upon those meteorological questions which are the common concern of all nations, and whom we are specially glad to welcome as members of this Sub-section. Their presence and their scientific work are proof, if proof is required, that meteorologists cannot regard meteorological problems as dissociable from Section A; that the prosecution of meteorological research is by the study of the kinematics, the mechanics, the physics, or the mathematics of the data compiled by laborious observation of the earth's atmosphere.

But this is not the first occasion upon which the Address from the Chair of the Sub-section has been devoted to Meteorology. Many of you will recollect the trenchant manner in which a university professor, himself a meteorologist, an astronomer, a physicist, and a mathematician, dealt candidly with the present position of Meteorology. After that Address I am conscious that I have no claim to be called a meteorologist according to the scientific standard of Section A. Prof. Schuster has explained—and I cannot deny it—that the responsible duty of an office from which I cannot dissociate myself is signing weather reports; and I could wish that the duty of making the next Address had been intrusted to one of my colleagues from across the sea. But as Prof. Schuster has set forth the aspect of official meteorology as seen from the academic standpoint with a frankness and candour which I think worthy of imitation, I shall endeavour to put before you the aspect which the relation between Meteorology and academic science wears from the point of view of an official meteorologist whose experience is not long enough to have hardened into that most comfortable of all states of mind, a pessimistic contentment.

Meteorology occupies a peculiar position in this country. From the point of view of Mathematics and Physics, the problems which the subject presents are not devoid of interest, nor are they free from that difficulty which should stimulate scientific effort in academic minds. They afford a most ample field for the display of trained intellect, and even of genius, in devising and applying theoretical and experimental methods. And can we say that the work is unimportant? Look where you will over the countries which the British Association may be supposed to represent, either directly or indirectly, and say where a more

satisfactory knowledge of the laws governing the weather would be unimportant from any point of view. Will you take the British Isles on the eastern shores of the Atlantic, the great meteorological laboratory of the world, with the far-reaching interests of their carrying trade; or India, where the phenomena of the monsoon show most conspicuously the effects of the irregular distribution of land, the second great meteorological cause, and where recurring famines still overstrain the resources of administration. Take the Australasian colonies and the Cape, which, with the Argentine Republic, where Mr. Davis is developing so admirably the methods of the Weather Bureau, constitute the only land projections into the great southern ocean, the region of "planetary meteorology": Australia, with its periods of paralysing drought; the Cape, where the adjustment of crops to climate is a question of the hour; or take Canada, which owns at the same time a granary of enormous dimensions and a large portion of the Arctic Circle; or take the scattered islets of the Atlantic and Pacific or the shipping that goes wherever ships can go. The merest glance will show that we stand to gain more by scientific knowledge, and lose more by unscientific ignorance of the weather, than any other country. The annual loss on account of the weather would work out at no inconsiderable sum per head of the population, and the merest fraction of success in the prevention of what science must regard as preventable loss would compensate for half a century of expenditure on meteorological offices. Or take a less selfish view and consider for a moment our responsibilities to the general community of nations, the advantages we possess as occupying the most important posts of observation. If the meteorology of the world were placed, as perhaps it ought to be, in the hands of an International Commission, it can be no exaggeration to say that a considerable majority of the selected sites for stations of observation would be on British soil or British ships. We cannot help being the most important agency for promoting or for obstructing the extension of meteorological science. I say this bluntly and perhaps crudely because I feel sure that ideas not dissimilar from these must occasionally suggest themselves to every meteorologist, British or foreign; and if they are to be expressed—and I think you will agree with me that they ought to be—a British meteorologist ought to take the responsibility of expressing them.

And how does our academic organisation help us in this matter of more than parochial or even national importance? There was a time when Meteorology was a recognised member of the large physical family and shared the paternal affection of all professors of Physics; but when the poor nestling began to grow up and develop some individuality electricity developed simultaneously with the speed of a young cuckoo. The professors of Physics soon recognised that the nest was not large enough for both, and with a unanimity which is the more remarkable because in some of these academic circles utilitarianism is not a condition of existence, and pure science, not market value, might be the dominant consideration—with singular unanimity the science which bears in its left hand, if not in its right, sources of wealth beyond the dreams of avarice was recognised as a veritable Isaac, and the science wherein the fruits of discovery must be free for all the world, and in which there is not even the most distant prospect of making a fortune—that science was ejected as an Ishmael. Electrical engineering has an abundance of academic representatives; brewing has its professorship and its corps of students, but the specialised physics of the atmosphere has ceased to share the academic hospitality. So far as I know the British universities are unanimous in dissembling their love for Meteorology as a science, and if they do not actually kick it downstairs they are at least content that it has no encouragement to go up. In none is there a professorship, a lectureship, or even a scholarship, to help to form the nucleus of that corps of students which may be regarded as the primary condition of scientific development.

Having cut the knot of their difficulties in this very human but not very humane method, the universities are, I think, disposed to adopt a method of justification which is not unusual in such cases; indications are not wanting which disclose an opinion that Meteorology is, after all, not a science. There are, I am aware, some notable exceptions; but do I exaggerate if I say that when university professors are kind enough to take an interest in the labours of meteorologists, who are doing their best amid many discouragements, it is generally to point out that their work is on the wrong lines; that they had better give it up and do something else? And the interest which the universities display in a general way is a good-humoured jest about the futility of weather prophecy, and the kindly suggestion that the improvement in the prediction of the next twenty-four hours' weather is a natural limit to the orbit of an Ishmaelite's ambition.

In these circumstances such an Address as Prof. Schuster's is very welcome: it recognises at least a scientific brotherhood and points to the responsibility for a scientific standard; it even displays some of the characteristics of the Good Samaritan, for it offers his own beast on which to ride, though it recommends the unfortunate traveller to dispose of what little clothing the stripping has left to provide the two pence for the host.

It is quite possible that the unformulated opinion of the vast majority of people in this country who are only too familiar with the meteorological vagaries of the British Isles is that the weather does just as it pleases; that any day of the year may give you an August storm or a January summer's day; that there are no laws to be discovered, and that the further prosecution of so unsatisfactory a study is not worth the time and money already spent upon it. They forget that there are countries where, to judge by their languages, the weather has so nearly the regularity of "old time" that one word is sufficient to do duty for both ideas. They forget that our interests extend to many climates, and that the characteristics of the eastern shores of the North Atlantic are not appropriate to, say, western Tropical Africa. That may be a sufficient explanation of the attitude of the man in the street, but as regards the British universities dare I offer the difficulty of the subject as a reason for any want of encouragement? Or shall I say that the general ignorance on the part of the public of the scientific aspirations and aims of meteorologists and of the results already obtained is a reason for the universities to keep silence on the subject? With all respect I may say that the aspect which the matter presents to official meteorologists is that the universities are somewhat oblivious of their responsibilities and their opportunities.

I have no doubt that it will at once be said that Meteorology is supported by Government funds, and that alma mater must keep her maternal affection and her exiguous income for subjects that do not enjoy State support. I do not wish just now to discuss the complexities of alma mater's housekeeping. I know she does not adopt the same attitude with regard to astronomy, physics, geology, mineralogy, zoology, or botany, but let that pass. From the point of view of the advancement of science I should like to protest against the idea that the care of certain branches of science by the State and by the universities can be regarded as alternative. The advancement of science demands the co-operation of both in their appropriate ways. As regards Meteorology, in my experience, which I acknowledge is limited, the general attitude towards the department seems to be dictated by the consideration that it must be left severely alone in order to avoid the vicious precedent of doing what is, or perhaps what is thought to be, Government work without getting Government pay, and the result is an almost monastic isolation.

There is too much isolation of scientific agencies in this country. You have recently established a National Physical Laboratory the breath of whose life is its association with the working world of physics and engineering, and you have put it—where? At Cambridge, or anywhere else where young physicists and engineers are being trained? No; but in the peaceful seclusion of a palace in the country, almost equidistant from Cambridge, Oxford, London, and everywhere else. You have established a Meteorological Office, and you have put it in the academic seclusion of Victoria Street. What monastic isolation is good for I do not know. I am perfectly certain it is not good for the scientific progress of Meteorology. How can one hope for effective scientific development without some intimate association with the institutions of the country, which stand for intellectual development and the progress of science?

I could imagine an organisation which by association of

the universities with a central office would enable this country, with its colonies and dependencies, to build up a system of meteorological investigation worthy of its unexampled opportunities. But the co-operation must be real and not one-sided. Meteorology, which depends upon the combination of observations of various kinds from all parts of the world, must be international, and a Government department in some form or other is indispensable. No university could do the work. But whatever form Government service takes it will always have some of those characteristics which, from the point of view of research, may be called bondage. On the other hand, research, to be productive, must be free with an academic freedom, free to succeed or fail, free to be remunerative or unremunerative, without regard to Government audits or House of Commons control. Research looks to the judgment of posterity with a faith which is not unworthy of the Churches, and which is not among those excellent moral qualities embodied in the Controller and Auditor General. *Die academische Freiheit* is not the characteristic of a Government department. The opportunity which gave to the world the "Philosophiæ Naturalis Principia" was not due to the State subvention of the Deputy Mastership of the Mint, but to the modest provision of a professorship by one Henry Lucas, of whose pious benefaction Cambridge has made such wonderful use in her Lucasian professors.

The future of Meteorology lies, I believe, in the association of the universities with a central department. I could imagine that Liverpool or Glasgow might take a special interest in the meteorology of the sea; they might even find the means of maintaining a floating observatory; and when I say that we know practically nothing of the distribution of rainfall over the sea, and we want to know everything about the air above the sea, you will agree with me that there is room for such an enterprise. Edinburgh might, from its association with Ben Nevis, be desirous of developing the investigation of the upper air over our land; in Cambridge might be found the author of a book, on the principles of atmospheric physics, worthy of its Latin predecessor; and for London I can assign no limited possibilities.

If such an association were established I should not need to reply to Prof. Schuster's suggestion for the suppression of observations. The real requirement of the time is not fewer observations, but more men and women to interpret them. I have no doubt that the first expression of such an organisation would be one of recognition and acknowledgment of the patience, the care, the skill, and the public spirit—all of them sound scientific characteristics—which furnish at their own expense those multitudes of observations. The accumulated readings appal by their volume, it is true, but they are, and must be, the foundation upon which the scientific structure will be built.

So far as this country is concerned when one puts what is in comparison with what might be it must be acknowledged that the tendency to pessimistic complaisance is very strong. Yet I ought not to allow the reflections to which my predecessor's Address naturally gave rise to be too depressing. I should remember that, as Dr. Hellmann said some years ago, Meteorology has no frontiers, and each step in its progress is the result of efforts of various kinds in many countries, our own not excluded. In the presence of our guests to-day, some of whom know by practical experience the advantages of the association of academic liberty with official routine, remembering the recent conspicuous successes in the investigation of the upper air in France, Germany, Austria, and the United States, and the prospect of fruitful co-operation of meteorology with other branches of cosmical physics, I may well recall the words of Clough:—

Say not, the struggle nought availeth . . .
And as things have been, things remain.

If hopes were dupes, fears may be liars;
It may be, in yon smoke concealed
Your comrades chase e'en now the fliers,
And, but for you, possess the field.

For while the tired waves, vainly breaking,
Seem here no painful inch to gain,
Far back, through creeks and inlets making,
Comes silent, flooding in, the main.

And not by eastern windows only,
When daylight comes, comes in the light;
In front, the sun climbs slow, how slowly,
But westward, look, the land is bright.

Official meteorologists are not wanting in scientific ambitions and achievements. It is true that Prof. Hann, whose presence here would have been so cordially welcomed, left the public service of Austria to continue his services to the world of science by the compilation of his great handbook, and Snellen is leaving the direction of the weather service of the Netherlands for the more exclusively scientific work of directing an observatory of terrestrial physics; but I am reminded by the presence of Prof. Mascart of those services to meteorological optics and terrestrial magnetism that make his place as President of the International Committee so natural and fitting; and of the solid work of Angot on the diurnal variation of the barometer and the reduction of barometric observations for height that form conspicuous features among the many valuable memoirs of the Central Bureau of Paris.

Of the monumental work of Hildebrandsson in association with Teisserenc de Bort on clouds, which culminated quite recently in a most important addition to the pure kinematics of the atmosphere, I hope the authors will themselves speak. Prof. Willis Moore's presence recalls the advances which Bigelow has made in the kinematics and mechanics of the atmosphere under the auspices of Prof. Moore's office, and reminds us of the debt of gratitude which the English-speaking world owes to Prof. Cleveland Abbé, of the same office, for his treatment of the literature of atmospheric mechanics.

If General Rykatcheff had only the magnificent climatological Atlas of the Russian Empire to his credit he might well rest satisfied. Prof. Mohn's contributions to the mechanics of the atmosphere are examples of Norwegian enterprise in the difficult problems of Meteorology, while Dr. Paulsen maintains for us the right of meteorologists to share in the results of the newest discoveries in physics. Davis's enterprise in the far south does much to bring the southern hemisphere within our reach, while Chaves places the meteorology of the mid-Atlantic at the service of the scientific world. Need I say anything of Billwiller's work upon the special effect of mountains upon meteorological conditions, or of the immense services of the joint editors of the *Meteorologische Zeitschrift*, Prof. Pernter, of Vienna, and Dr. Hellmann, of Berlin; of Palazzo's contributions to terrestrial magnetism? The mention of Eliot's Indian work, or of Russell's organisation of Australian meteorology, will be sufficient to show that the dependencies and colonies are prepared to take a share in scientific enterprise. And if I wished to reassure myself that even the official meteorology of this country is not without its scientific ambitions and achievements, I would refer not only to Scott's many services to science but also to Strachey's papers on Indian and British Meteorology and to the official contributions to Marine Meteorology.

There is another name, well known in the annals of the British Association, that will for ever retain an honoured place among the pioneers of meteorological enterprise—that of James Glaisher, the intrepid explorer of the upper air, the Nestor of meteorologists, who has passed away since the last meeting of the Association.

I should like especially to mention Prof. Hergesell's achievements in the organisation of the international investigation of the upper air by balloons and kites, because it is one of the departments which offers a most promising field for the future, and in which we in this country have a good many arrears to make up. I hope Prof. Hergesell will later on give us some account of the present position of that investigation, and I am glad that Mr. Rotch, to whose enterprise the development of what I may call the scientific kite industry is largely due, is present to take part in the discussion.

Yet with all these achievements it must be confessed that the progress made with the problems of general or dynamical Meteorology in the last thirty years has been disappointing. When we compare the position of the subject with that of other branches of Physics it must be allowed that it still lacks what astronomy found in Newton, sound in Newton and Chladni, light in Young or Fresnel, heat in Joule, Kelvin, Clausius, and Helmholtz, and electricity in Faraday and Maxwell. Above all, it lacks its

Kepler. Let me make this clear. Kepler's contribution to physical astronomy was to formulate laws which no heavenly body actually obeys, but which enabled Newton to deduce the law of gravitation. The first great step in the development of any physical science is to substitute for the indescribably complex reality of nature an ideal system that is an effective equivalent for the purposes of theoretical computation. I cannot refrain from quoting again from Plato's "Republic" a passage which I have quoted elsewhere before. It expresses paradoxically but still clearly the relation of natural philosophy to natural science. In the discussion of the proper means of studying sciences Socrates is made to say "We shall pursue astronomy with the help of problems just as we pursue geometry: but we shall let the heavenly bodies alone if it is our design to become really acquainted with astronomy." What I take to be the same idea is expressed in other words by Rayleigh in the introduction to his "Sound." He there points out as an example that the natural problem of a sounding tuning-fork really comprises the motion of the fork, the air, and the vibrating parts of the ear; and the first step in sound is to simplify the complex system of nature by assuming that the vibrations of the fork, the air, and the ear can be treated independently. Frequently this step is a most difficult one to take. What student of nature, contemplating the infinity of heavenly bodies and unfamiliar with this method of idealism, would imagine that the most remarkable and universal generalisation in physical science was arrived at by reducing the dynamics of the universe to the problem of three bodies? When we look round the sciences each has its own peculiar ideals and its own physical quantities: astronomy has its orbits and its momentum, sound its longitudinal vibration, light its transverse vibration, heat its energy and entropy, electricity its "quantity" and its wave, but meteorology has not yet found a satisfactory ideal problem to substitute for the complexity of nature. I wish to consider the aspect of the science from this point of view and to recall some of the attempts made to arrive at a satisfactory modification of reality. I do not wish to refer to such special applications of physical reasoning as may be involved in the formation of cloud, the thermodynamics of a mixture of air and water vapour, the explanation of optical or electrical phenomena, nor even Helmholtz's application of the theory of gravitational waves to superposed layers of air of different density. These require only conventions which belong already to physics, and though they may furnish suggestions they do not themselves constitute a general meteorological theory.

The most direct efforts to create a general theory of atmospheric circulation are those which attempt to apply Newtonian dynamics, with its more recent developments on the lines of hydrodynamics and thermodynamics. Attempts have been made, mathematical or otherwise, to determine the general circulation of the atmosphere by the application of some form of calculation, assuming only the sun and a rotating earth, with an atmosphere, as the data of the problem. I confess that these attempts, interesting and ingenious as they are, seem to me to be somewhat premature. The "problem" is not sufficiently formulated. When Newton set to work to connect the motions of the heavenly bodies with their causes, he knew what the motions of the heavenly bodies were. Mathematics is an excellent engine for explaining and confirming what you know. It is very rarely a substitute for observation, and before we rely upon it for telling us what the nature of the general circulation of the atmosphere really is, it would be desirable to find out by observation or experiment what dynamical and elastic properties must be attributed to an extremely thin sheet of compressible fluid rotating about an axis with a velocity reaching 1000 miles an hour, and subject to periodic heating and cooling of a very complicated character. It would be more in consonance with the practice of other sciences to find out by observation what the general circulation is before using mathematics to explain it. What strikes one most about the mathematical treatises on the general circulation of the atmosphere is that what is true about the conclusions is what was previously known from observation. It is, I think, clear that that method has not given us the working ideal upon which to base our theory.

Consider next the attempts to regard atmospheric phenomena as periodic. Let me include with this the correlation of groups of atmospheric phenomena with each other or with those of the sun, when the periodicity is not necessarily regular, and the scientific process consists in identifying corresponding changes. This method has given some remarkable results by the comparison of the sequence of changes in the meteorological elements in the hands of Pettersen and Meinardus, and by the comparison of the variation of pressure in different parts of the globe by Sir Norman Lockyer and Dr. W. J. S. Lockyer; as regards the earth and the sun the subject has reached the stage of productive discussion. As a matter of fact, by continuing this Address I am preventing Sir Norman Lockyer from telling you all about it.

For the purpose of dealing with periodicity in any form we substitute for nature an ideal system obtained by using mean values instead of individual values, and leaving out what, from this point of view, are called accidental elements. The simplification is perfectly legitimate. Passing on to the consideration of periodicity in the stricter sense the process which has been so effective in dealing with tides, the motions of the liquid layer, is very attractive as a means of attacking the problems of the atmosphere, because, in accordance with a principle in dynamics, to every periodic cause there must correspond an effect of the same period, although the relation of the magnitude of the effect to the cause is governed by the approximation of the natural period of the body to that of the cause.

There are two forms of the strict periodic method. One is to examine the generalised observations for periodicities of known length, whether it be that of the lunar rotations or of sunspot frequency, or of some longer or shorter period. In this connection let me acknowledge a further obligation to Prof. Schuster for tacking on to his Address of last year a development of his work on the detection of hidden periodicities by giving us a means of estimating numerically what I may call the reality of the periodicity. The other method is by harmonic analysis of a series of observations with the view of finding causes for the several harmonic components. I may say that the Meteorological Office, supported by the strong opinion of Lord Kelvin, has favoured that plan, and on that account has for many years issued the hourly results for its observatories in the form of five-day means as representing the smallest interval for which the harmonic analysis could be satisfactorily employed. Sir Richard Strachey has given some examples of its application, and the capabilities of the method are by no means exhausted, but as regards the general problem of dynamic meteorology harmonic analysis has not as yet led to the disclosure of the required generalisation.

I ought to mention here that Prof. Karl Pearson, with the assistance of Miss Cave, has been making a most vigorous attempt to estimate the numerical value of the relationship, direct or inverse, between the barometric readings at different places on the earth's surface. The attempt is a most interesting one as an entirely new departure in the direction of reducing the complexity of atmospheric phenomena. If it were possible to find coordinates which showed a satisfactory correlation it might be possible to reduce the number of independent variables and refer the atmospheric changes to the variations of definite centres of action in a way that has already been approached by Hildebrandsson from the meteorological side.

Years ago, when Buys Ballot laid down as a first law of atmospheric motion that the direction of the wind was transverse to the barometric gradient and the force largely dependent upon the gradient, and when the examination of synchronous charts showed that the motion of air could be classified into cyclonic and anticyclonic rotation, it appeared that the meteorological Kepler was at hand, and the first step towards the identification of a working meteorological unit had been taken—the phenomena of weather might be accounted for by the motion and action of the cyclonic depression, the position of the ascending current, the barometric minimum. The individual readings over the area of the depression could be represented by a single symbol. By attributing certain weather conditions to certain parts of the cyclonic area and supposing that the depression travelled with more or less unchanged characteristics the vagaries of weather changes can be accounted for. For

thirty years or more the depression has been closely watched, and thousands of successful forecasts have been based upon a knowledge of its habits. But unfortunately the travelling depression cannot be said to preserve its identity in any sense to which quantitative reasoning can be applied. As long as we confine ourselves to a comparatively small region of the earth's surface the travelling depression is a real entity, but when we widen our area it is subject to such variations of path, of speed, of intensity, and of area that its use as a meteorological unit is seriously impaired, and when we attempt to trace it to its source or follow it to its end it eludes us. Its origin, its behaviour, and its end are almost as capricious as the weather itself.

Nor if we examine other cases in which a veritable entity is transmitted can we expect that the simple barometric distribution should be free from inexplicable variations. We are familiar with ordinary motion, or, as I will call it, astronomical motion, wave motion, and vortex motion. Astronomical motion is the motion of matter, wave motion the motion of energy, vortex motion the motion of matter with energy, but the motion of a depression is merely the transmission of the locus of transformation of energy; neither the matter nor the energy need accompany the depression in its motion. If other kinds of motion are subject to the laws of conservation of matter and conservation of energy, the motion of the depression must have regard also to the law of dissipation of energy. An atmospheric disturbance, with the production of rainfall and other thermal phenomena, must comply in some way with the condition of maximum entropy, and we cannot expect to account for its behaviour until we can have proper regard to the variations of entropy. But the conditions are not yet in a form suitable for mathematical calculation, and we have no simple rules to guide us. So far as Meteorology is concerned, Willard Gibbs unfortunately left his work unfinished.

When the cyclonic depression was reluctantly recognised as too unstable a creature to carry the structure of a general theory Mr. Galton's anticyclones, the areas of high pressure and descending currents, claimed consideration as being more permanent. Prof. Köppen and Dr. van Bebber have watched their behaviour with the utmost assiduity and sought to find therein a unit by which the atmospheric changes can be classified; but I am afraid that even Dr. van Bebber must allow that his success is statistical and not dynamical. "High pressures" follow laws on the average, and the quantity we seek is not an average but an individual.

The question arises, whether the knowledge of the sequence of weather changes must elude us altogether, or will yield to further search. Is the man in the street right after all? But consider how limited our real knowledge of the facts of atmospheric phenomena really is. It may very well be that observations on the surface will never tell us enough to establish a meteorological entity that will be subject to mathematical treatment; it may be that we can only acquire a knowledge of the general circulation of the atmosphere by the study of the upper air, and must wait until Prof. Hergesell has carried his international organisation so far that we can form some working idea therefrom of general meteorological processes. But let us consider whether we have even attempted for surface meteorology what the patience of astronomers from Copernicus to Kepler did for astronomy.

Do we yet fully comprehend the kinematics of the travelling depression; and if not, are we in a satisfactory position for dealing with its dynamics? I have lately examined minutely the kinematics of a travelling storm, and the results have certainly surprised me and have made it clear that the travelling depressions are not all of one kinematical type. We are at present hampered by the want of really satisfactory self-recording instruments. I have sometimes thought of appealing to my friends the professors of physics who have laboratories where the reading of the barometer to the thousandth of an inch belongs to the work of the "elementary class," and of asking them to arrange for an occasional orgy of simultaneous readings of the barometer all over the country with corresponding weather observations for twenty-four consecutive hours, so that we might really know the relation between pressure, rainfall, and temperature of the travelling depressions; but I fear the area covered would even then hardly be large enough, and we must improve our self-recording instruments.

Then, again, have we arrived at the extremity of our knowledge of the surface circulation of the atmosphere? We know a great deal about the average monthly distribution, but we know little about the instantaneous distribution. It may be that by taking averages we are hiding the very points which we want to disclose.

Let me remind you again that the thickness of the atmosphere in proportion to the earth's surface is not unsatisfactorily represented by a sheet of paper. Now it is obvious that currents of air in such a thin layer must react upon each other horizontally, and therefore we cannot *a priori* regard one part of the area of the earth's surface as meteorologically independent of any other part. We have daily synoptic charts for various small parts of the globe, and the Weather Bureau extended these over the northern hemisphere for the years 1875 to 1879; but who can say that the meteorology of the northern hemisphere is independent of that of the southern? To settle that primary question we want a synchronous chart for the globe. As long as we are unable to watch the changes in the globe we are to a certain extent groping in the dark. A great part of the world is already mapped every day, and the time has now arrived when it is worth while to consider what contributions we can make towards identifying the distribution of pressure over the globe. We may idealise a little by disregarding the local peculiarities without sacrificing the general application. I have put in the exhibition a series of maps showing what approximation can be made to an isochronous chart of the globe without special effort. We are gradually extending the possibility of acquiring a knowledge of the facts in that as in other directions. With a little additional enterprise a serviceable map could be compiled; and when that has been reached, and when we have added to that what the clouds can tell us, and when the work of the Aëronautical Committee has so far progressed that we can connect the motion of the upper atmosphere with the conditions at the surface, when we know the real kinematics of the vertical and horizontal motion of the various parts of a travelling storm, we shall, if the universities will help us, be able to give some rational explanation of these periodic relations which our solar physics friends are identifying for us, and to classify our phenomena in a way that the inheritors of Kepler's achievements associated with us in this Section may be not unwilling to recognise as scientific.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. W. N. HARTLEY, D.Sc., F.R.S., F.R.S.E., PRESIDENT OF THE SECTION.

THE ofttimes laborious method of investigating the relationship of substances by ascertaining how one form of matter can operate upon another, in other words by chemical reactions, has of late been supplemented by the examination of their physical properties, and has been extended to compounds, both organic and inorganic. In several directions this has led to results of very uncommon interest. Accordingly I propose to offer a brief account of twenty-five years' experimental work in that branch of chemical physics which deals with the emission and absorption of rays of measurable wave-length, and to review its present position chiefly in relation to the theory of chemistry, indicating where it may be usefully and profitably extended.

According to Davy ("Chemical Philosophy," vol. i., 1812, p. 211), Ritter observed chemical action on moist chloride of silver to be different in different parts of the spectrum, slight in the red, greater towards the violet, and entending into a space beyond the violet where there is no sensible light or heat. Wollaston discovered that chemical action was exerted by refracted rays in a region where they were of a higher refrangibility than any rays that were visible. Young showed that the invisible rays are liable to the same affections as visible rays. Hence we have the beginnings of spectrum analysis in its chemical relations to terrestrial matter, in the infra-red, the visible, and the ultra-violet regions.

Everyone is more or less familiar with the subject of spectrum analysis. This was defined by Tait as an optical method of making a diagnosis of the chemical composition of either (*a*) a self-luminous body, or (*b*) an absorbing medium, whether self-luminous or not. It has now become necessary to enlarge this definition, and I would suggest that it is the study of the composition and the constitution of matter by means of radiant energy, and recording in the order of their refrangibilities the rays emitted and absorbed by matter. By this modified statement the infra-red or so-called "invisible heat rays," the visible or "colour rays," and the ultra-violet or "chemical rays" are included.

Spectra are of two kinds, emission and absorption spectra. It will be convenient if the latter are considered first.

ABSORPTION SPECTRA.

The Infra-red Region.

Abney (1880) by the preparation of a particularly sensitive form of collodion emulsion containing silver bromide was successful in obtaining very extraordinary results. Such films as he prepared were so sensitive to invisible radiations of long wave-length as to be capable of forming a representation of even a kettle of boiling water, standing in an absolutely dark room. This picture could not of course be properly referred to as a photograph, though the process by which it was obtained was such as we are accustomed to term a photographic process. It may with greater propriety be termed an actinograph, the result not of light, but of dark rays. The least refrangible of the visible rays lies about wave-length 7800 ten-millionths of a millimetre, or Ångström units; but these rays extend as far as wave-length 12,000, while Becquerel has measured lines in the spectra of metals of as low a refrangibility as wave-length 18,000.

Abney and Festing (1881) investigated the influence of atomic groupings in the molecules of organic substances by measuring their absorption in the infra-red region of the spectrum.

They studied such simply constituted substances as water, hydrochloric acid, chloroform, carbon tetrachloride, and cyanogen, besides many hydrocarbons with their hydroxyl, haloid, and carboxyl derivatives. Characteristic groups of lines or very narrow bands were observed in carbon compounds, but they are absent from carbon compounds containing no hydrogen, and do not all appear in some of the hydrogen compounds. The facts observed led to the conclusion that they belonged to hydrogen, but are subject to some occasional modifications. Oxygen in hydroxyl, for instance, modifies two of the lines, since it obliterates by absorption the rays which lie between them. Oxygen in aldehyde, or when it forms part of the carbon nucleus of some such compound, presents bands which are bounded by well-defined lines, or are inclined to be linear. These appear to be characteristic bands indicating the carbon nucleus of a series of substances. Alkyl radicals, such as ethyl, exhibit absorption bands, and so does the benzene nucleus. It is a remarkable fact that bands appear in the solar spectrum which correspond with those of benzene (1881).

Julius (1893) has investigated the absorption in the infra-red caused by many carbon compounds by means of the bolometer, combined with a prism, and also with a diffraction grating. He showed that the molecules of compound substances absorbed the rays which were emitted at the time of their formation. Thus, to take the simplest case, the emission spectrum of hydrogen burning in air corresponds with the absorption bands of water vapour, that is to say, the absorption spectra of the compounds are the counterpart of the emission spectra of the flames which yield these compounds during combustion. The emission spectrum of carbon dioxide is found in the spectrum of burning carbon monoxide, cyanogen, methane, and carbon disulphide; and that of water-vapour in various hydrocarbons. As early as 1888 Julius, in an Inaugural Dissertation, quoting Tyndall, recognised that the absorption and emission of rays measured with the thermopile were manifestations of the molecular vibrations.

The various absorption spectra examined included those of the alcohols, such as isopentylic, isobutylic, normal butylic, propylic, ethylic, and methylic, as well as hydrocarbons, chloroform, and benzene. The study of the maxima of radiation and the maxima of absorption offers us a means of arriving at a knowledge of a series of new and valuable physical constants, namely, the vibration periods characteristic of the molecules. (Tyndall discussed this subject in his usually luminous style on pp. 391 to 402 of his work "Heat as a Mode of Motion.")

Puccianti (1900) has examined the infra-red absorption spectra of liquids, including aromatic compounds and alkyl derivatives, while Donath has examined in the same region various essential oils. Carbon combined with hydrogen shows a maximum of absorption with a wave-length about (1·71 μ mm.) 17,100 . ngström units.

Benzene and pyridine have two other maxima of absorption in common. The alcohols have very similar maxima of absorption at wave-length 21,000.

The three isomeric xylenes show absorption spectra which are almost identical. At or about wave-length 23,200 another maximum of absorption is shown.

Julius refers to Langley's observation that at a wave-length of 27,000 there is an abrupt termination to the solar spectrum, probably caused by the water vapour in the atmosphere; but a band extends to 273,000, and at no very great elevation above the earth's surface there are rays with a wave-length of 45,700 Ångström units. All radiations of longer wave-length—and Julius has measured down to 149,000 Ångström units—are likely to be absorbed by the carbon dioxide in the atmosphere.

The Visible Rays or Colour Region.

J. L. Schönn (1879) examined the absorption spectra of substances usually considered to be colourless in layers from 1·6 to 3·7 metres in thickness and observed narrow bands in the spectra of methyl, ethyl, and amyl alcohol, lying in the red, orange, and yellow; methyl alcohol showed two bands, ethyl and amyl alcohol each three. Gerard Krüss (1888) calculated the wave-lengths of these bands, and it appears that the higher members of the homologous series have the bands displaced towards the red end of the spectrum. Russell and Lapraik (1879) made similar observations on columns of liquid from two to eight feet in length. All the substances gave well-defined absorption bands lying between wave-lengths 6000 and 7000.

The bands of the different substances differed altogether from the bands of water. Alcohols give a band which is similar in different alcohols, but the higher the alcohol stands in the homologous series, that is to say, the larger the number of carbon atoms it contains, the nearer is the band to the red end of the spectrum (1881).

It was definitely established that for each CH_2 introduced into a molecule of ammonia or benzene there is a shifting of the absorption bands towards the red end of the spectrum.

It will, of course, be understood that the liquids examined were perfectly colourless in the ordinary acceptation of the term; and that they appear so is owing to the bands of absorption being very narrow, so that the percentage of luminous rays withdrawn by absorption is but a very small fraction of the whole spectrum emitted by a source of light when viewed under ordinary conditions.

Numerous observations were made by Melde, Burger, Magnus, H. W. Vogel, and Landauer (1876–78), which showed that changes in the absorption spectra of solutions are partly physical and partly chemical, that is to say, they are caused by changes in the constitution of the solution. Vogel mentions cases where no chemical change was believed to take place, as, for instance, where naphthalene red shows different spectra according to whether it is dissolved in alcohol, water, resin, or is solid or used to colour paper (1878).

This points to some difference in the constitution of the solution. A well-known instance is that of iodine in alcohol, chloroform, or carbon disulphide.

It must be observed that Vogel's work referred merely to phenomena observable in the visible spectrum, to small thicknesses of the absorbing medium, and was not applied quantitatively. Two solutions may give spectra which are apparently identical at one concentration, but spectra quite different when submitted to varying degrees of dilution.

In order to ascertain in what way absorption spectra are

related to the chemical constitution of organic substances, it is necessary to examine a wider range of spectrum than that included in the merely visible region, and this may be done by extending the observations into the ultra-violet.

The Ultra-violet Region.

Stokes in preparing his experiments for a Friday evening discourse at the Royal Institution observed that the spectrum of electric light when a prism and lenses of quartz were used extended no less than six or eight times the length of the visible spectrum. In 1862 he studied the ultra-violet spectra of metals and executed drawings of the lines exhibited by aluminium, zinc, and cadmium. He discovered the fact that certain solutions show light and dark bands in the spectrum of rays transmitted by them, the solutions being colourless; the bands are invisible unless they fall on a fluorescent screen. It was under such conditions that they exhibited light and darkness. The screen used was of plaster of Paris saturated with a fluorescent substance, such as uranium phosphate.

William Allen Miller in 1863, simultaneously with Stokes, described his method of examining the photographic transparency of various saline solutions and organic substances and of depicting metallic spectra. A sensitised photographic plate was used for the reception of the rays of the spectrum, so that they were made to register their own position and intensity. L. Soret invented the fluorescent eye-piece for the purpose of investigating the ultra-violet rays and ascertained the best media for the transmission of rays of high refrangibility. Colourless fluor-spar, a rare mineral, was found to answer best, and quartz lenses were achromatised with this. Iceland spar was found to absorb some of the more refrangible rays, and a pure spectrum was difficult to obtain with quartz prisms owing to double refraction, which caused the lines in metallic spectra to be duplicated. Struck by the fact that Miller had examined many organic substances without obtaining evidence of a connection between their constitution and their absorption spectra—the actual words used by Miller were, "I have not been able to trace any special connection between the chemical complexity of a substance and its diactinic power" (*Journ. Chem. Soc.*, vol. xi. p. 68)—it appeared to me desirable that this point should be systematically reinvestigated. L. Soret had already proceeded with work in this direction, by examining and drawing a great variety of organic substances and diagrams of absorption curves. But it was deemed necessary to make a large number of examinations of substances of a comparatively simple constitution, and according to theory closely related, and afterwards gradually to proceed to the study of substances of greater complexity. For such purposes a photographic method alone appeared a practicable one, particularly when comparisons had to be made between substances observed at different times, for the reason that none but photographic records could be absolutely relied upon and stored away for future reference.[1]

[1] Clerk Maxwell had calculated for Miller the best focal length of lenses of quartz which would give an approximately flat field. His computation made this something over a length of three feet. All Miller's photographs were taken with the plate placed normal to the axis of the lens, but Stokes had shown that the locus of the foci of the different rays formed an arc of a curve or nearly a straight line, lying very obliquely to the axes of the pencils coming through the lens.

It was obvious from Miller's photographs that only one or two rays on each plate were even approximately in focus. To obtain spectra in focus from end to end it was evidently necessary to incline the plate so that the end upon which the red rays would fall, which are of longest wave-length, should be farther off than that upon which the ultra-violet fall, which are of shortest wave-length. It was also found experimentally that lenses of much shorter focal length (ten or twelve inches) could be used, giving perfect definition, and, what is still more important, it was found a positive advantage not to have them corrected by fluor-spar or calcite. The plate carrier was adjusted at an inclination of approximately 22° to the normal; in such a position the rays from the yellow sodium line to the extreme ultra-violet of the spark spectrum of cadmium were simultaneously in focus on a plane surface.

The prism was of quartz cut on Cornu's plan, the method of construction designed to get rid of all double refraction being communicated to me by M. Cornu in a very kindly written letter. The first instrument was constructed in 1878 and the description of it published in 1881. It has been the model for several others. One with two prisms and lenses of 12 inches focus was exhibited by me in the Inventions Exhibition in 1882. At the Jubilee meeting of the British Association at York the spark spectra of iron, cobalt, and nickel, enlarged to twenty-five diameters and printed by the Autotype Company, were exhibited. They are more than 8 feet in length, and have proved very useful for reference. The photographic process is a point of great importance; the then newly invented gelatine bromide films made by Kennet were alone quite suitable.

The plan of the proposed investigation was to photograph the rays transmitted by molecular proportions of hydrocarbons, alcohols, acids, and esters, either alone as vapour or liquid, or dissolved in some neutral and, in comparison with the substances to be examined, an optically non-absorbent solvent.

It was considered that the metameric esters would afford much information if a sufficient number of them were examined and their spectra compared, and if the acids themselves were not responsive the sodium and potassium salts in solution would serve the purpose, since the alkalies did not affect the spectrum. The general deductions (1879) are now well known, but two points not generally taken into account were well established. First, the extraordinary delicacy of the ultra-violet spectrum in detecting traces of impurities. For instance, pyridine, an invariable impurity in commercial ammonia, is present in the proportion of about 1/30000th. It was proved that the absorption spectra of the normal paraffins prepared with the greatest care by Schorlemmer contained traces of impurities which could not be separated. Secondly, some of the normal alcohols could not be rendered pure by the ordinary methods employed, and great care was necessary in their preparation. It may well be asked that, if such were the case, upon what grounds was it concluded that impurities were present? How was it possible to distinguish between a normal and an abnormal absorption spectrum when no standards of comparison existed? It may be of interest if this question be now answered, as no adequate account of it has been made public. All the substances in any one homologous series were shown to vary in the extent to which the rays at the more refrangible end of the spectrum were absorbed, and the different terms of the series differ solely by the number of CH_2 groups in the molecule; and the greater the number of these the greater the absorption. The extent of the absorption should be proportional to the molecular weight of the substance. Accordingly if repeatedly purifying and fractionally distilling a considerable quantity of material failed to give spectra which were constant and identical, but gave instead spectra which were variable, even in a slight degree, it was evident that the absorption due to the molecule of the substance was interfered with by some impurity.

When, however, it became evident that successive quantities of methylic alcohol, for example, prepared in a certain manner yielded spectra which were practically identical under different conditions, such as thickness of liquid, and that they differed but slightly from that of pure water after the type of which the alcohol is constituted, the conclusion was inevitable that we were dealing with a pure preparation. In short, the longest spectrum obtained in all circumstances and under every reasonable condition could not possibly be the result of accident, more particularly if it could be repeatedly obtained from different specimens of the same substance. The same reasoning applies to the acids and their salts in the investigation of which similar difficulties arose.

Soret and Rilliet pointed out that in the rectification and prolonged desiccation of the alcohols there is often slight oxidation which leads to the production of impurities which affect the spectra transmitted by them.

They found that ethyl alcohol is not appreciably less diactinic than methyl alcohol, and both transmitted a spectrum nearly as long as that of water. This was shown by Huntington and me when the usual 25 mm. of thickness of the layer of liquid were tested. By taking columns of liquid 100 mm. in length the differences are greater, and they increase with columns of increased length.

The influence of each additional CH_2 in the molecule causes a shortening of the spectrum. This was shown to be due to the carbon atoms and not to the hydrogen. The acids, containing the same number of carbon atoms as the alcohols, have a much greater absorptive power, which is due to the carboxyl group (C : O · OH). By the examination of a number of various substances, such as polyhydric alcohols, as glycol, glycerol, mannitol, and various sugars, it was found that, no matter what its complexity, no open-chain compound causes selective absorption, *i.e.* absorption bands.

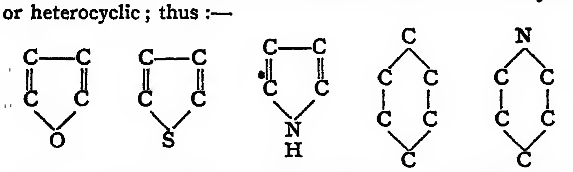
Shortly it may be stated that in the examination of organic substances we have three variations in absorption

spectra: First, those of substances the rays of which are freely transmitted, the absorption being at the more refrangible end of the spectrum, and the spectrum of which is readily increased in length by dilution; secondly, those in which the spectra are of the same kind, but the absorptive power is greater, so that they withstand dilution to a much greater extent; thirdly, those spectra which exhibit selective absorption, and which at the same time exert great absorptive power, or, in other words, can undergo great dilution before the absorption bands are rendered visible, and still further dilution before they are extinguished or obliterated.

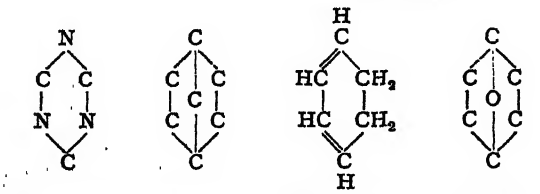
Spectra of the First Variety belong to substances which are constructed on an open chain of carbon atoms, thus: C·C·C·C·C or C=C·C·C·C and C≡C·C·C·C.

The introduction in place of one or more atoms of hydrogen—of hydroxyl, OH, carboxyl, COOH, methoxyl, OCH_3, CO, COH, or NH_3, or of side chains such as CH_3, C_2H_5, &c.—does not affect the character of the spectra, but merely the absorptive power, which is increased when oxygen or an oxygenated radical is introduced.

Spectra of the Second Variety are spectra of substances so constituted that the carbon atoms form a closed chain. It is immaterial whether the closed chains are homocyclic or heterocyclic; thus:—



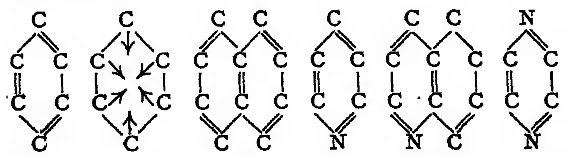
Furfurane Thiophene Pyrrol Diketohexamethylene Hydro-aromatic compounds Piperidine



Cyanuric Acid Camphor Dihydrobenzene Cineol

They possess greater absorptive power than open-chain compounds, but do not exhibit absorption bands. It is manifestly the chain or ring structure of the compounds that gives them greater absorptive power, and not the number of carbon atoms in the molecules.

Spectra of the Third Variety.—These show absorption bands, and the substances yielding them are generally constituted on the type of benzene, naphthalene, anthracene, phenanthrene, &c.; but the rings may be either homocyclic or heterocyclic without the character of the spectra being altered; thus:—



Benzene Benzene Naphthalene Pyridine Quinoline Pyrazine

If we say that the compounds which are homocyclic are constituted of at least three pairs of carbon atoms doubly linked, which are themselves singly linked together, we may make use of the formula of Kekulé for benzene as the simplest expression of their constitution; if we assume that each of the six atoms is linked to at least other two atoms we adopt what is practically the prism formula of Ladenburg, or the same idea expressed in space of two dimensions. It is difficult to express the physical condition by the Armstrong-Baeyer formula or centric arrangement because this does not clearly suggest to one's mind what is manifestly the fact, namely, that the carbon atoms in the nucleus of benzene are much more closely condensed or combined together than those of the hydroaromatic series. This condensed condition of the carbon atoms is evident from the higher molecular refractive energy of aromatic compounds and of the specific refractive energy of the carbon in such combinations.

Side chains such as do not exert selective absorption have no influence on the character of the spectra, but they slightly increase the general absorption.

Heterocyclic compounds possess greater absorptive power, both as regards the general and selective absorption, than those which are homocyclic.

The point which I particularly desire to direct attention to here is, that for the first time Kekulé's remarkable benzene theory was supported by definite physical measurements, and the closed-ring formula represented a veritable actuality.

Of Molecular and Intra-molecular Vibrations.

Johnstone Stoney was the first to show that the cause of the interrupted spectra of gases is to be referred to the motions within the individual molecules, and not to the irregular journeys or encounters of the molecules with each other; and this applies to the absorption as well as to emission spectra. He further advised the use of oscillation frequencies instead of wave-lengths in describing the measurements of spectra. Johnstone Stoney and Emerson Reynolds subsequently examined the extraordinary absorption exhibited by chlorochromic anhydride, the bands in which are evidently harmonically related.

It has already been shown that the hydrocarbons of the aromatic series exert two kinds of absorption, a general and a selective absorption. All the evidence we possess warrants the belief that the general absorption is caused by the motion of the molecules, while the selective absorption is due to the motion within the molecules.

When the molecule of a substance is capable of vibrating synchronously with a radiation, the ray received on this substance is absorbed. The absorption is complete if the direction of the vibration of the molecule and of the ray is the same but the phase opposite, and if the number of molecules in the path of the rays is sufficient to damp all the vibrations.

When the quantity of substance in the path of the rays is reduced, the number of molecules present is not sufficient to damp all the vibrations and some of the rays are transmitted. If, however, certain carbon atoms within the molecule are vibrating synchronously with certain rays, we shall have selective absorption of these rays after the general absorption has been so weakened by dilution or otherwise as to allow them to pass.

It is evident, then, that general absorption exerted by carbon compounds is due to the vibration of the molecules because the absorption increases with the number of carbon atoms in the molecule; or, in other words, in any homologous series the greater the molecular mass the lower the rate of vibration of the molecule.

It has not been found possible to associate any of the absorption bands of the substances examined with any particular carbon atoms; but the bands in benzene are six in number, or the same in number as the carbon atoms. It has, however, been shown that the rapidity of the intramolecular vibrations was dependent upon the rate of vibration of the molecules. From numbers representing approximately the mean wave-lengths of the four chief bands of rays absorbed by benzene, naphthalene, and anthracene, and from the velocity of light, the mean rate of the vibrations within the molecules was calculated (1881), the numbers being as follows:—

	Molecular Vibrations
Benzene	1248^{10}
Naphthalene	1177^{10}
Anthracene	910^{10}

The mean rate of vibration of the rays absorbed by naphthalene is less than that absorbed by benzene, and those of anthracene less than those of naphthalene. It follows from this that the vibrations within the molecules are not independent, but are a consequence, of the fundamental molecular vibrations, like the harmonics of a stretched string or of a bell.

The term absorptive power has generally been used with respect to the extent of rays of the spectrum absorbed, but there is intensity of absorption to be considered. In the case of a vibrating string or tuning-fork greater amplitude

of vibration means a louder note; in the case of molecules greater intensity of absorption may be caused by a greater amplitude of vibration in the molecules of the absorbing medium, the number of molecules being constant. But by greater amplitude it is not to be understood that the rate of vibration is increased.

If this be so then, as the absorption intensity of anthracene and naphthalene is, molecule for molecule, greater than that of benzene, the amplitude of vibration of the molecules of these substances is greater, but the rate of vibration is slower.

From the foregoing it will be observed that where λ is the wave-length $1/\lambda$ is the inverse wave-length, omitting the correction for the refraction of air which is a very small value, it is the oscillation frequency of the ether in a small unit of time, and the most convenient measurement for use in describing spectra. Seven years after the publication of these views Gerard Krüss (1888) dealt with the subject of coloured substances in a similar manner. From the undulatory theory of light, deductions may be drawn regarding the inner molecular movements or inter-atomic movements within the molecules, inasmuch as the vibrations of the ether, which fills the intra-molecular space, are a resultant within that space of the velocity and amplitude of the molecular vibrations.

Thus, if λ be the wave-length of a ray emitted by a substance, and v the velocity of light, the number of vibrations, n, which a molecule sends forth by movements of it as a whole and of its parts can be determined by the equation $n = v/\lambda$.

G. Krüss made a series of calculations for coloured substances similar to those which I had made for colourless substances and for ozone.

Curves of Molecular Vibrations.

Observations on absorption spectra should, whenever it is possible, be made with reference to the quantity of substance which produces a given measurable effect. A molecular weight in milligrams or a milligram-molecule is a convenient quantity which may be dissolved in 20 c.c., 40 c.c., or 100 c.c. of any non-absorbent liquid, and observed through thicknesses of the solution varying from 25 mm. to 1 mm. in thickness. When a series of photographs has been measured a curve is plotted, which shows the general and the selective absorption of the substance. The oscillation frequencies of the absorbed rays are taken as abscissæ, and the proportional thickness in millimetres of the weakest of a series of solutions as ordinates. The curves are as often as possible made continuous, and they are called *curves of molecular vibrations.*

The curves of the molecular vibrations present very striking features: they are valuable physical constants which enable one to classify and identify substances.

Position Isomerism.

Isomerides of the *ortho-*, *meta-*, and *para-*positions in aromatic substances yield spectra with the absorption bands, differing in position, in width, and in intensity. There is no distinguishing character to be observed in the different isomerides. Isomerism in the pyridine, quinoline, and naphthalene derivatives has not yet been completely studied. In such cases as have already passed under review there is nothing that indicates the positions of the substituted hydrogens.

Stereo-isomerism.

Where isomerism is not due to differences in structure, but simply to the distribution of the atoms in space, we have no means of distinguishing isomeric substances from an examination of their spectra; for instance, benz-*syn*-aldoxime and benz-*anti*-aldoxime yield curves of molecular vibrations which are identical.

Tautomerism.

The possibility of an atom of hydrogen occupying alternative positions in a compound

$$(NH \cdot C : O \rightleftarrows N : C \cdot OH)$$

so that it may be united to an atom of nitrogen or of carbon in one instance, or to an atom of oxygen in another, easily gives rise to substances with different characters, the one that of a phenol, the other that of a ketone. One interpretation of the facts observed which has been very commonly received may be stated thus. Certain compounds have in their constitution an atom of hydrogen of a "roving disposition" which at one time will attach itself to an atom of oxygen, or to an atom of nitrogen, and anon it will forsake one of these and unite itself to an atom of carbon. The consequence of this "instability of character" is that when a derivative of the compound is being prepared or sought for by a chemical process, which according to all previous knowledge ought to yield it, the substance brought forth is of a different class, but withal of the same composition; it is, in fact, an isomeride.

According to another theory, the two isomeric derivatives of the parent substance are present in equal proportions in a solution in a state of equilibrium, and upon crystallisation one or other of these assumes the solid form. Taking those cases where a substance has a constitution which it is believed has been correctly ascertained by chemical reactions, and which yields two isomeric alkyl derivatives, it becomes a question as to which of these the parent substance has directly given birth to. The evidence from chemical reactions has in many cases failed to give a satisfactory answer, but the curves of molecular vibrations of such substances afford the desired information concerning the relationship of their constitution to that of their respective derivatives.

Most convincing evidence has been afforded by observations on their spectra, that several of the parent substances are really not what they seem to be.

Thus, isatin and methyl pseudo-isatin yield curves which are almost identical, the sole difference between them being due to the substitution of the alkyl radical for hydrogen, the nature of which difference might have been predicted.

Clearly the parent substance and the pseudo-derivative are of the same nature and constitution.

Carbostyril and methyl-pseudo-carbostyril, *o*-oxycarbanil and its ethyl ether, obtained by boiling with potash and ethyl iodide, are also similarly related, and they possess the ketonic or lactam structure.

On the other hand methylisatin, carbostyril, and the other ether of *o*-oxycarbanil yield curves which are essentially different from the foregoing, and are enolic or of the lactim type. Generally speaking, the ketonic are more stable than the enolic forms. Dibenzoyl-methane is ketonic, and the tautomeric substance oxybenzal-acetophenone is enolic, and in this instance the enolic form is that with the greatest stability. The two substances yield different curves, and the gradual change of the less stable into the more stable form can be traced by photographing the spectra of the solutions at intervals.

The ethyl esters of dibenzoyl succinic acid are of interest in this connection. There are three isomers known out of the thirteen which are possible, and the spectra of these have been studied. Knorr has given three formulæ for what he designates the α, β, and γ esters. Of these there are two, the β and γ forms, which give identical absorption curves: they are of the ketonic type, and structurally identical, but configuratively different, being stereo-isomerides.

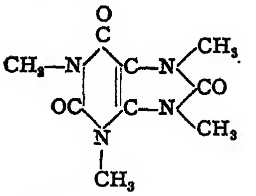
The curve of molecular vibrations of the α ester is quite different from that common to the β and γ compounds. The α compound is of the enolic type, and it changes spontaneously at ordinary temperatures into the ketonic, thus showing that in this case also the latter is the more stable. The transition from the one form into the other was seen to be in progress, and after an interval of only three hours the absorption band of the enolic ester had almost entirely disappeared. In three weeks the transformation had become complete, as was shown by the molecular vibration curve of the α ester being almost exactly coincident with that of the β and γ forms.

Another interesting example is afforded by the study of phloroglucinol, it being a substance with a constitution of a somewhat doubtful character, for owing to the ambiguity of its behaviour towards chemical reagents it is impossible to arrive at a decision from chemical evidence whether the oxygen atoms are present in enolic or ketonic groups. Towards some substances it behaves as a phenol, towards others as a ketone. The doubt also presented itself as to

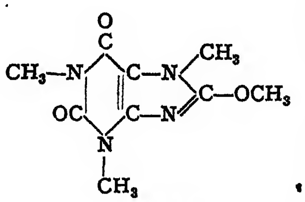
whether phloroglucinol from various sources had the same constitution, and, further, whether there might not be two isomeric forms of the compound present in equal proportions in a solution of the substance. Specimens of phloroglucinol prepared in five different ways from different materials gave curves of molecular vibrations which were identical: this decided the question absolutely; they are one and the same substance. If the constitution of the substance is that of a trihydroxybenzene or phenol, then the trimethyl ether should exhibit an absorption curve differing but slightly in detail from that of the parent substance; and, furthermore, the latter should exhibit a general resemblance to the curves of pyrogallol and phenol. This was found actually to be the case in both particulars.

Finally, with regard to tautomerism, it may be considered as decided that no evidence has been obtained based upon either physical measurements or chemical reactions of, first, the presence of a "wandering" atom of hydrogen as a characteristic of compounds which exhibit tautomerism; secondly, that solutions of tautomeric compounds do not contain equal quantities of the two substances, or enolic and ketonic forms in equilibrium, and that if both are present one so greatly preponderates over the other that no trace of any but the one compound can be detected; thirdly, it has been observed that some substances do change spontaneously from one form to another, and that this change sets in very quickly after the substance has been dissolved; fourthly, that substances change from one form to another under the influence of different reagents, as, for instance, cotarnine, as Dobbie and Lauder (1903) have shown, in presence of methyl alcohol or of caustic soda, and again in presence of potassium cyanide. In fact it appears that under the influence of different reagents one or other of the two compounds is the more stable, and the more stable substance is then formed.

A reaction is recorded in the researches of Emil Fischer where it appears that two tautomeric forms are produced simultaneously from oxycaféine. When the silver salt of this substance is heated with methyl iodide it yields a mixture of tetramethyl uric acid and methoxycaféine, the characteristic groupings in which are $-NH-CO-$ and $-N=COH-$, the hydrogens being methylated. This is a singular reaction which has not yet been studied spectrographically.



Tetramethyluric Acid.



Methoxycaféine.

The Absorption Spectra of Alkaloids.

The interest attached to an examination of the absorption spectra of the alkaloids is not alone the fact that a means of recognising, detecting, and estimating such substances was devised, but still more that we may learn something of their chemical constitution. Many of the poisonous alkaloids give no distinctive chemical reactions, and in certain cases the means of recognising them are restricted to observations on their crystalline form and their physiological action. The physiological action of certain alkaloids of an extremely deadly character is remarkable enough to prove a means of their identification when the effect on the human subject is under observation. The first experimental work on the absorption spectra of the alkaloids arose out of a celebrated trial for murder, which engaged much attention in the year 1882. It was proved that the lethal drug administered was aconitine.

To identify this substance, of which there are several varieties, it was necessary at that time to resort to physiological tests made upon small animals.

Such a course always affords an opportunity for forensic arguments based upon the evidence adduced. To substitute absolute physical measurements for physiological tests seemed to present facilities for securing justice by removing any doubt of the identity of an unknown substance with the nature of one which is known. Alkaloids yield spectra of two kinds, those which do not and those which do exhibit absorption bands, the difference between the two classes of substances being one dependent on the constitution of the nucleus or ultimate radical of the compound. It is possible not only to identify substances, but also to determine the quantity present in a mixture or solution, and this has actually been done.

Alkaloids which are derived from benzenoid hydrocarbons, pyridine, quinoline, or phenanthrene give evidence of their origin by their spectra. It is therefore advantageous to make a careful study of the absorption spectra of the substances themselves and of the various products derived from them when studying their constitution. It was remarked while the work was in progress that the quinine spectrum curve was probably due to the conjugation of four pyridine or two quinoline nuclei. It is known now to be a substance of a complicated structure containing one quinoline nucleus. It differs from cinchonine only by one methoxyl group in the *para*-position. Observations made on simple bases differ from those made on substitution products, such as alkyl derivatives, in this respect, that the bases are the more diactinic, while addition products, such as hydrogenised compounds, and also salts of the alkaloids such as hydrochlorides, are more diactinic than the simple bases. It was shown by the researches of Alder Wright that different preparations of aconitine can yield substances slightly differing in constitution. On examining them it was shown that these preparations yielded different absorption curves the variations in which were due to differences in the constitution of the different preparations. To state a particular case of a well-defined character, the aconitine from *aconitum napellus* and japaconitine from a Japanese aconite prepared by Alder Wright had practically the same absorption spectrum and yielded similar curves; but that of japaconitine was just what might be expected from a substance with a nucleus of a similar constitution, but about twice the molecular weight of aconitine; in other words, a condensation of two molecules of aconitine into one—namely, what was observed in the spectra of morphine and apomorphine, a much greater absorptive intensity with a similar absorption curve.

It was shown that japaconitine has a constitution modified in such a manner; it being, in fact, what was termed by Alder Wright a sesquiapoaconitine; and the formulæ given for these substances are respectively: Aconitine, $C_{34}H_{47}NO_{11}$; japaconitine, $C_{66}H_{88}N_2O_{21}$, which is in agreement with the spectrum observations. It has, however, been supposed by Freund and Beck that the two substances are identical.

Strychnine and brucine are two alkaloids evidently closely related, but little is known about their constitution; both seem to contain a pyridine nucleus united to what is probably a pyrrolic nucleus, the two constituting a conjugated nucleus resembling that of quinoline. The difference between brucine and strychnine is said to be simply that the former contains two methoxyls. The absorption curves show a wider difference than this, and it was predicted that strychnine appears to be a derivative of pyridine, but brucine is more probably a derivative of tetrahydroquinoline, or an addition product of quinoline of the same character, since there is a remarkable similarity between the curves of the two substances. I would suggest that for the future evidence from their spectra be taken into account in studying their constitution.

Stereo-isomerism in the Alkaloids.

Many alkaloids having the same formula are stereoisomerides, and those related in this manner exhibit molecular absorption curves which are identical. The following examples are quoted by Dobbie and Lauder (1903) as the result of their investigations: dextro-corydaline and inactive corydaline; narcotine and gnoscopine; tetrahydroberberine and canadine. Where two compounds are known to have the same formula, and one of these is optically active, the other inactive, it may be inferred, as Dobbie and Lauder have pointed out, that they are not optical isomerides if their absorption curves are different; thus canadine and papaverine have the same formula, but their absorption curves show that they are structurally different.

It is a general rule that substances which agree closely in structure exhibit similar series of absorption spectra, while those which differ essentially in structure show absorption curves which are different; and to this rule neither aromatic compounds, alkaloids, nor dyes and coloured substances form any exceptions. That this is so is easily understood from the theory of absorption spectra. It must, however, be distinctly understood that the essential feature of importance in all such investigations is the quantitative relation of the substance to its spectra, whether these relations are based upon equal weights of material or equimolecular proportions in solutions of given volume and thickness.

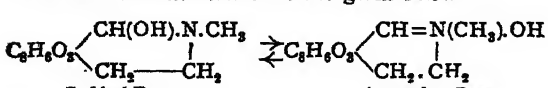
The relationship of morphine, $C_{17}H_{17}NO(OH)_2$, and codeine, or methylmorphine, $C_{17}H_{17}NO.(OH)(OCH_3)$, was shown by their spectra, the latter being a homologue of the former. A similar instance has been investigated recently by Dobbie and Lauder. The resemblance between the spectra of laudanine, $C_{20}H_{25}O_4N$, and laudanosine, $C_{21}H_{27}O_4N$, confirms the view that they are homologous bases. The close agreement of their absorption curves with those of corydaline and tetrahydropapaverine clearly indicates a similarity in structure to that of these alkaloids, but the relationship of laudanosine to corydaline is probably closer than to tetrahydropapaverine, and may be best explained by the formulæ

$$\underset{\text{Corydaline}}{C_{22}H_{27}O_4N} - CH_2 + H_2 = \underset{\text{Laudanosine}}{C_{21}H_{27}O_4N}$$

The removal of a methyl group from such a compound would scarcely cause any appreciable change in the curve of molecular vibrations, and very many cases are known where, when two atoms of hydrogen are introduced into a compound without altering the close linking of the carbon atoms of the ring formation in the compound, the alteration in the spectrum is insignificant.

A particularly interesting example of tautomerism already mentioned has been observed by Dobbie and Lauder in studying the constitution of cotarnine, a substance prepared from narcotine. Three formulæ have been proposed for it: one represents it as an aromatic aldehyde in which one hydrogen is replaced by an open change containing nitrogen; a second gives it the character of a carbinol base; while a third that of an ammonium base. It has been supposed that in solution it is a mixture of two or all three such substances in a state of equilibrium, but as to what is the formula to be assigned to solid cotarnine the data are insufficient to determine. There are, however, two different solutions of the substance obtainable; that in ether or chloroform is quite colourless, like the solid; but a solution in water or alcohol is yellow. From the molecular absorption spectra of these solutions and of certain derivatives with which they are compared there is very distinct evidence that a solution in alcohol or water contains the ammonium base, while under the influence of sodium hydroxide it assumes the condition of the carbinol form. Moreover, the rate of transformation and the conditions which influence this isomeric change have been studied. It suffices here to state that a solution containing entirely the one form may be converted wholly into the other.

The two formulæ referred to are given below:—



Carbinol Form Ammonium Base

EMISSION SPECTRA.

Spark Spectra and their Constitution.

As it became necessary to make accurate measurements of absorption spectra in the ultra-violet, the work of obtaining the wave-lengths of lines in twenty metallic spectra was undertaken. They were for the most part in a region which, except in the case of two or three elements, had not been previously explored. A small Rutherford grating was employed, combined with quartz lenses with a focal length of three feet. Experience has shown that it was advisable in describing these spectra to give measurements in hundredths of an inch of the positions of the lines on the published photographs of the prismatic spectra in the *Journal* of the Chemical Society (March, 1882), and to follow Lecocq de Boisbaudran by giving a description of the character of each of the lines. In this way they are easily identified, and the value of the measurements for practical purposes is greatly enhanced. Prior to the publication of the work (1882), in the prosecution of which Dr. Adeney was associated with me, Liveing and Dewar, who had been engaged on a similar investigation, but operating in a different manner, published an account of the spectra of the metals of the alkalies and alkaline earths, and subsequently the lines of iron, nickel, and cobalt. They showed a rhythmic grouping of the lines to be characteristic of the spectra of the alkali metals.

In connection with the prismatic spectra which were photographed some remarkable facts were noticed; for instance, the character of the lines belonging to different groups of elements was a noticeable feature, as well also their disposition or arrangement, more particularly in the ultra-violet. Similarities in the visible spectra of zinc and cadmium, of calcium, strontium, and barium, and in those of the alkali metals had been observed by Mitscherlich, by Lecocq de Boisbaudran, and also by Ciamician. As to the grouping of the lines as observed on the photographs, it appeared that the spectra of well-defined groups of elements had characteristics in common which were different from those of other groups. For instance, the alkali metals differed from the alkali earth metals which appeared to form a group by themselves. Then in marked contrast to these simple spectra were those of iron, nickel, and cobalt, which though very complicated were seen to be much alike. Nearest to these but differing from them in certain respects were the palladium, gold, and platinum spectra.

It was observed how these elements with certain chemical and physical properties in common could be recognised as being relations owing to their family likeness when their spectra were photographed. Then it was remarked that the spectra of magnesium, zinc, and cadmium, had distinctive characters in common; for instance, the individual lines in these spectra were marked by similar characteristics, such as a great extension of the strong lines above and below the points of the electrodes. This extension was increased with the atomic mass of the metal, and with the greater atomic mass in this group the volatility of the metal is also greater. An arrangement of the lines in pairs and triplets was noticed, the triplets being repeated, but less distinctly than in the first instance, and again repeated sharply but less strongly, so that there were three different sets of triplets in each spectrum. The point of greatest interest and importance was the connection traced between the atomic mass and the numerical differences observed in the intervals between the lines of different groups when measured by their oscillation frequencies.

These differences were not in the spectrum of one element, but were in the lines of each metal of the group, and were clearly associated with the atomic mass and chemical properties in each case.

The arrangement of the lines, which was common to all the metals in the magnesium, zinc, cadmium group, may shortly be described as follows:—Three isolated lines and one pair of lines in magnesium, with four sets of triplets; one isolated line and one pair of lines in zinc, with three sets of triplets; one isolated line and one pair of lines in cadmium, with three sets of triplets.

Besides the arrangement of these lines there were in the spectrum of each element two groups of the most refrangible lines, consisting one of a quadruple group and the other of a quintuple group, the groups and the lines composing them being similarly disposed in each spectrum. It was, however, not distinctly proved that these particular groups were strictly homologous, the most refrangible lines in the zinc spectrum being very difficult to photograph even on specially prepared plates, though the lines are strong. It was furthermore observed that with an increase in the atomic mass the distances between the lines both in pairs and triplets were greater. The same was the case with the quadruple and quintuple groups. In the magnesium spectrum, if we compare the first with the second group of triplets, we find the intervals extending from the first line in the first group to the first line in the second group, and from the second line in the first group to the second line

in the second group, and from the third line in the first group to the third line in the second group, when measured in terms of oscillation frequencies to be 677·1, 677·0, and 677·4. Similarly taking the second and third groups it is 391·2, 391·1, and 391·1. Between the third and fourth groups in like manner it is 230 9, 233, and 233; so that the intervals diminish with increase of refrangibility of the lines.

In the zinc spectrum the intervals between the lines in the first and second groups are 910, 910, and 910; in the second and third groups 582, 581, and 583.

In the cadmium spectrum the corresponding intervals are 801·5, 800, and 800; in the second and third groups 588, 589, and 587. The more accurately the lines are measured the more exactly do these differences correspond. It is scarcely necessary to point out that the differences in the atomic masses of the elements are in round numbers where H=1, Mg 24, Zn 65, and Cd 112.

The *Law of Constant Differences* rendered it evident that the spectra of the elements were subject to a law of homology, which was closely connected with the atomic mass and with their chemical and physical properties.

It was, in fact, found, in accordance with the periodic law, that the spectra of definite groups were spectra similarly constituted, from which it was deduced that they are produced by similarly constituted molecules. It is evident that there is periodicity in their spectra. The metals studied being all monatomic in their molecular condition, the conclusion was inevitable that the atoms were of complex constitution, and that not only was the complex nature of these atoms disclosed, but it was also shown that groups of elements with similar chemical and physical properties, the atomic weights of which differed by fixed definite values, were composed of the same kind of matter, but the matter of the different elements was in different states of condensation, as we know it to be in different members of the same homologous series of organic compounds. If this were not the case, the mass or quantity of matter in the atom would not affect in the same manner its rate of vibration—which the facts observed lead us to conclude that it does—and the chemical properties of the substances would differ more widely from one another, and the differences between them would not be gradational, which in fact they are. It was thus impossible to believe that the atoms were the ultimate particles of matter, though so far as chemical investigations had proceeded they were parts which had not been divided. Here the conviction was forced upon one that matter might exist in a state which had hitherto been unrecognised by those who accepted the atomic theory without searching beneath it. All that the atomic theory enabled the chemist to take account of were the laws of combination and decomposition of the forms of matter that are ponderable and of sufficient mass to be weighable on the finest balances, which after all are but crude and imperfect instruments for the study of matter, since they are capable only of determining differences between masses of tangible size. It became conceivable that matter in the state of gas or vapour might become so attenuated that repulsion of the molecules would be greater than the attraction; that they would then no longer form aggregates, and in consequence would cease to be weighable. In such a condition they may be imagined to constitute the ether, and in view of this conception there may be recognised four physical conditions of material substances, namely, solid, liquid, gas, and ether.

It is more than twenty years ago since the study of homology in spectra led me to the conviction that the chemical atoms are not the ultimate particles of matter, and that they have a complex constitution.

That the atoms of definite groups of chemically related elements are composed of the same kind of matter in different states of condensation is not a dream or a view of a visionary character, for it is based upon definite observations controlled by exact physical measurements, and is therefore in the nature of a theory rather than an hypothesis. Batchinski (1903) regards the atoms as being in a state of vibration, and the periods of vibration of related elements appear to stand in a simple relation to their properties. The mass of an atom is proportional to the square of its period of vibration, and conversely the vibration period of the atom may be calculated from the square root of the atomic weight. These values have been calculated and arranged according to Mendeléeff's classification, whereby it is shown that there is a decided tendency to form harmonic series in the vertical columns. The deviations are probably capable of explanation, as the author believes, on the ground that the atom is not to be regarded as a material point, but as a material system. It is well to remember that the precursor of the Periodic Law was Newland's Law of Octaves.

I have always experienced great difficulty in accepting the view that because the spectrum of an element contained a line or lines in it which were coincident with a line or lines in another element it was evidence of the dissociation of the elements into simpler forms of matter. In my opinion, evidence of the compound nature of the elements has never been obtained from the coincidence of a line or lines exclusively belonging to the spectrum of one element with a line or lines in the spectrum exclusively belonging to another element. This view is based upon the following grounds:—First, because the coincidences have generally been shown to be only apparent, and have never been proved to be real; secondly, because the great difficulty of obtaining one kind of matter entirely free from every other kind of matter is so great that where coincident lines occur in the spectra of what have been believed to be elementary substances they have been shown from time to time to be caused by traces of foreign matter, such as by chemists are commonly termed impurities; thirdly, no instance has ever been recorded of any homologous group of lines belonging to one element occurring in the spectrum of another, except and alone where the one has been shown to constitute an impurity in the other; as, for instance, where the triplet of zinc is found in cadmium and the triplet of cadmium in zinc; the three strongest lines in the quintuple group of magnesium in graphite, and so on. The latest elucidation of the cause of coincidences of this kind arises out of a tabulated record from the wave-length measurements of about three thousand lines in the spectra of sixteen elements made by Adeney and myself. The instances where lines appeared to coincide were extremely rare; but there was one remarkable case of a group of lines in the spectrum of copper which appeared to be common to tellurium; also lines in indium, tin, antimony, and bismuth which seemed to have an origin in common with those of tellurium.

It is difficult to separate tellurium from copper, and copper from tellurium, by ordinary chemical processes. Dr. Köthner, of Charlottenburg, has succeeded in obtaining very pure tellurium from the spectrum of which these lines and also several others have been almost entirely eliminated, which shows that they are foreign to the element, and that his specimen of tellurium is probably purer than any previously obtained. For determining the atomic weight of tellurium it is of course necessary to obtain it in the greatest possible state of purity; and it may be mentioned that the material which Staudenmaier employed for this purpose was found, from Köthner's photograph of its spectrum, to be a very pure specimen.

The prosecution of researches in connection with the constitution of spectra was initiated by Johnstone Stoney, by Balmer with respect to hydrogen, and continued by Rydberg, Deslandres, Ames, and, above all, by Kayser and Runge, who by an elaborate and exhaustive investigation of the arc spectra of the elements have given us formulæ by which the wave-lengths of lines in the spectra of different elements in certain definite groups may be calculated. They also showed the spectra to be constituted of three series of lines, the principal series and two subordinate series, one sharp and the other diffuse.

Ramage, however, has given us a simpler formula, depending on the atomic weight, which applies to several groups, and he has co-ordinated the spectra of several of the elements with the squares of their atomic masses, and also their atomic masses with other of their physical properties.

It may here be remarked that the homology of the spark spectra in the magnesium, zinc, and cadmium series was at first called in question by Ames, though he proved the arc spectra of zinc and cadmium to be strictly homologous.

Preston decided the question by demonstrating by means of beautiful photographs that corresponding lines such as the pairs, triplets, and the quadruple groups in the spark spectra of the three metals when under the influence of a

very powerful magnetic field underwent the same kind of change; for instance, each quadruple group changed to sextuple, the second and fourth lines in each group becoming double. Lines in spectra which have not the same constitution behave differently. Recently Runge and Paschen have arrived at the same conclusion; and, furthermore, have established homology in the spectra of sodium, copper, and silver; also between aluminium and thallium. Indium is almost certainly homologous with aluminium and thallium, but it was probably not investigated on account of its rarity. Marshall Watts has pointed out that a relationship exists between the lines in the spectra of some elements and the squares of their atomic weights, from which it is possible to calculate the atomic weight of an element if that of another in the same homologous series is known, and the oscillation frequencies of corresponding lines are known.

The knowledge of spectra we now possess enables the determination of atomic weights to be controlled with quite as much efficiency and certainty in many instances as by specific heat or vapour-density determinations.

The first application of the observed homology in spectra was directed towards the question of the atomic mass of beryllium, for which purpose the lines in the ultra-violet spark spectrum of this element were first photographed and measured. The nature of the evidence on the subject adduced at the time was in outline as follows:—

"If, as Nilson and Petterson suggest, the position of beryllium is at the head of a series of triad rare earth metals, the element scandium (at. wt. 44) and yttrium (at. wt. 89) must be members of the same group. If this be the case the spectra of the three elements must have certain characters in common, for the series of which aluminium and indium are the first and third terms yield strictly homologous spectra. As a matter of fact no two spectra could be more dissimilar than those of beryllium and scandium."

Having compared the photographs and wave-length measurements of a large number of spectra of the elements, I felt justified in making the following remarks:—

"The spectrum of beryllium exhibits no marked analogy with the calcium, the magnesium, or the aluminium spectra, all of which are members of well-defined homologous series. There is nothing similar in it to the boron, silicon, or carbon spectra, nor to those of the scandium, yttrium, or cerium. The spectrum of lithium is most closely analogous to that of beryllium in the number, relative positions, and intensities of the lines. This leads to the conclusion that beryllium is the first member of a dyad series of metals, to which in all probability calcium, strontium, and barium, as a sub-group, are homologous, its atomic mass being 9·2, its place is above magnesium." Subsequently Nilson, and also Humpidge, by chemical evidence and from vapour-density determinations of certain compounds, substantiated the conclusion previously arrived at by Emerson Reynolds, that the atomic mass of beryllium was not 13·8 but 9·2.

The next practical application of the spark spectra was to the analysis of rhabdophane, a mineral found many years ago in Cornwall and described by Heuland in 1837 as a zinc blende of a peculiar character.

This mineral I found to contain neither zinc nor sulphur, and therefore it is not a blende. It is, in fact, a phosphate of the formula $R_2O_3.P_2O_5.2H_2O$, in which the oxides of cerium, didymium, lanthanum, and yttrium may wholly or in part replace each other. The didymium absorption spectrum is well seen both by reflection from the surface and transmission through thin sections of the mineral. The spark spectrum of the yttrium chloride obtained from rhabdophane was compared with that observed by Thalén and ascribed to yttrium. Of the fifty-one lines in the spectrum of yttrium thirty-eight were absent from the yttrium obtained from rhabdophane, and it was concluded that the purest yttrium was that which yielded the simplest spectrum. This was the first occasion of the finding of yttrium in any British mineral. Quite recently a confirmation of this view has been obtained by comparing this spectrum with lists of the arc lines of yttrium and ytterbium which have just been published by Kayser (1903).

Penfield analysed a mineral found in the United States which he named scovellite: it proved to be identical in species with rhabdophane.

Flame Spectra at High Temperatures.

What are commonly known in the chemical laboratory as flame spectra are chiefly those of the metals of the alkalies and alkaline earths; also of gallium, indium, and thallium. The researches of Mitscherlich and Lecocq de Boisbaudran first showed that copper, manganese, and gold gave flame spectra. Lockyer, Gouy, and Marshall Watts also investigated flame spectra.

In 1887 I used iridium wires one millimetre thick, twisted into loops upon which fragments of minerals were heated in the oxygen blowpipe flame. Natural silicates yielded spectra not only of alkalies but of the alkaline earths, and also distinct manganese spectra. Baryta, strontia, and lime gave spectra when insoluble compounds such as the sulphates were thus examined at high temperatures. Iron, cobalt, and nickel gave spectra even when compounds such as the oxides were heated strongly. But iridium, though infusible, is somewhat volatile, and contributes a line spectrum to the flame. In 1890 thin slips of the mineral kyanite and even pieces of tobacco pipe were used instead. Experience with this method of working went to show how the flame spectra of oxides of calcium, strontium, and barium could be separated from those of lithium, sodium, potassium, rubidium, and cæsium, as observed in the Bunsen flame. Furthermore, that even the most volatile of these substances could be made to yield a continuous coloration from a single bead of salt for a period exceeding fifteen minutes, and extending to one or two hours, so that measurements of the lines might be made with some degree of certainty.

In order to study the flames emitted from furnaces during metallurgical operations, and particularly from the mouth of Bessemer vessels, it became necessary to ascertain what really were the lines of the elements observed under different conditions at a high temperature, and accordingly systematic methods of study were developed from the previous somewhat tentative experiments.

In all the flame spectra obtained by the oxyhydrogen blowpipe the ultra-violet line spectrum emitted by water vapour which had been discovered by Huggins and by Liveing and Dewar was visible on the photographs by reason of the combustion of the hydrogen in the hydrocarbon, or the hydrogen gas itself, when burnt along with oxygen. The flame spectra are always shorter than those obtained from the arc or from condensed sparks. After an extended examination of spectra produced by the oxyhydrogen blowpipe from solid substances, the knowledge obtained was applied to the examination of the flames coming from the Bessemer vessel during the "blow" during all periods from the commencement to the termination. These observations were made at the London and North-Western Railway Steel Works at Crewe; and at Dowlais, in South Wales. In collaboration with Mr. Ramage, a large number of these complicated spectra were photographed at the North-Eastern Steel Works, where the Thomas-Gilchrist process is carried out. The spectra were fully described and measured, with the result that every one of the lines and bands was accounted for. A new line belonging to potassium was discovered to have peculiar properties. Gallium was proved to be present in the Cleveland ore from Yorkshire, in the finished metal, in clays and in all aluminous minerals, even in corundum. Also, by very accurate determinations of the wave-lengths of its principal lines, gallium was proved to be a constituent of the sun. Moreover it was found in several meteorites. Pure gallium oxide was separated, by analytical methods, from iron ores and other materials; and the proportion of the metal in the steel rails made by the North-Eastern Steel Company, of Middlesbrough, was determined and found to be one part in thirty thousand. This Yorkshire steel is richer in gallium than any other substance from which it has been extracted; for instance, the Bensburg blende, supposed hitherto to be the richest ore, contains only one part in fifty thousand.

By observations on the spectra, the thermo-chemistry of the Bessemer process of steel manufacture was studied, and the temperatures attained under varying conditions were estimated. The demonstration of the great volatility of most metals, and of many metallic oxides in an undecomposed condition, at the temperature of the oxyhydrogen blowpipe and of the Bessemer flame was of special interest.

The metals chiefly referred to are copper, silver, lead, tin, manganese, chromium, iron, cobalt, nickel, palladium, gold, and iridium. Several of these, such as silver and gold, have lately been distilled *in vacuo* by Krafft.

Banded Flame Spectra.

Well-defined groups of elements yield banded flame spectra which have a similar constitution; thus magnesium, zinc, and cadmium yield bands composed of fine lines, degraded towards the violet, while fluted band spectra of beryllium, aluminium, and indium were found to be degraded towards the red. Thallium also yields a fluted spectrum; gallium gives a line spectrum; lanthanum gives bands degraded towards the red; palladium gives bands in the nature of flutings composed of fine lines; germanium gave very faint indications of bands; rhodium and iridium both lines and bands. It became manifest that elements belonging to the same group in the periodic system of classification exhibited banded spectra which are similarly constituted, and hence similarly constituted molecules of the elements have similar modes of vibration, whether at the lower temperature of the flame or at the higher temperature of the arc or spark. Banded spectra are thus shown to be connected with the periodic law.

A great advantage is to be derived from an investigation of banded spectra from a theoretical point of view, as well as from the application of this method to the analysis of terrestrial matter. While the spectra are easily obtained, they can be applied in a very simple manner to the chemical analysis of minute quantities of material, and may readily be made quantitative.

M. Armand de Gramont has described a method of obtaining spectra of metals and metalloids by means of a spark, and has given the analysis of eighty-six mineral species. The novelty and importance of his work lies in the method of obtaining spectra of such constituent substances as chlorine, bromine and iodine, sulphur, selenium and tellurium; also phosphorus and carbon when in a state of combination, as sulphates, phosphates, carbonates, &c.

There is a possibility of utilising this method for the quantitative determination of carbon, sulphur, and phosphorus in iron and steel during the process of manufacture.

Definition of an Element.

In a discussion on the question of the elementary character of argon in 1895 it was pointed out by me that argon gave a distinct spark spectrum by the action of condensed sparks, and therefore, on this evidence alone, it must be regarded as an element. The fact that it gave two spectra under different conditions was not opposed to, nor did it invalidate, this evidence, because such an element as nitrogen not only emits two spark spectra, but the two spectra can be readily photographed simultaneously from the same spark discharge.

It was proposed by M. de Gramont at the International Congress in Paris in 1900, and agreed, that no new substance should be described as an element until its spark spectrum had been measured and shown to be different from that of every other known form of matter.

This appears to me to have been one of the most important transactions of the Congress. The first application of this rule has resulted in the recognition of radium as a new element: it is characterised by a special spark spectrum of fifteen lines which have been fully studied and measured by Demarçay. It shows no lines of any other element.

Another application of this rule has recently been made by Exner and Haschek with preparations of the oxide of an element obtained by Demarçay, and named europium. It exhibits 1193 spark lines and 257 arc lines.

I have already mentioned that one feature strikingly shown in the spectra of chemically related elements was the wider separation of the lines in pairs, triplets, or other groups; was in some way related to the atomic mass, since the separation was greater in those elements the atomic weights of which were greater. Kayser and Runge, and also Rydberg, have shown that in the series of alkali metals the differences between the oscillation frequencies of the lines are very nearly proportional to the squares of the atomic weights. Runge and Precht have recently shown that in every group of elements that are chemically related the atomic weight is proportional to some power of the distance separating the two lines of the pairs of which the spectrum is constituted. In other words, if the logarithms of the atomic weight and distance between the lines be taken as coordinates the corresponding points of a group of elements which are chemically related will lie on a straight line. Applying this law to the determination of the atomic weight of radium they find that the strongest lines of the new element are exactly analogous to the strongest barium lines, and to those of the closely related elements magnesium, calcium, and strontium. The intervals between the two lines of each pair in the principal series, and in the first and second subordinate series, if measured on the scale of oscillation frequencies, are equal for each element, and the same law holds good for the spectrum of radium. From this the value 257·8 was found for the atomic mass of the element. This does not quite accord with the number obtained by Madame Curie, who found it to be 225. It will be interesting to see which number will eventually be proved to be the more correct.

It is now many years since I first pointed out that the absolute wave-lengths of the lines of emission spectra of the elements are physical constants of quite as great importance in theoretical chemistry as the atomic weights; in the light of recent discoveries this statement may be said to be now fully justified.

Radio-active Elements.

From the study of rays of measurable wave-lengths we have lately sailed under the guidance of M. Henri Becquerel into another region where it is doubtful whether all the rays conform to the undulatory theory. In fact some of the rays are believed to be charged particles of matter, charged, that is to say, with electricity. Beyond doubt they are possessed of very extraordinary properties, inasmuch as they are able to penetrate the clothing, celluloid, gutta percha, glass, and various metals. They are, moreover, endowed with a no less remarkable physiological action, producing blisters and ulcerations in the flesh which are difficult to heal. It is an established fact that such effects have been caused by only a few centigrams of a radium compound contained in a glass tube enclosed in a thin metallic box carried in the pocket.

From this we can quite understand that there is no exaggeration in the statement attributed to the discoverer, Prof. Curie, by Mr. W. J. Hanmer, of the American Institute of Electrical Engineers, that he would not care to trust himself in a room with a kilogram of pure radium, because it would doubtless destroy his eyesight, burn all the skin off his body, and probably kill him.

It remains for me to express regret that without an undue extension of the time devoted to this Address it would have been scarcely possible to afford adequate treatment to the absorption spectra of inorganic compounds, particularly those of the rare earths, and such also as afford evidence of the chemical constitution of saline solutions; or of organic compounds closely related to coloured substances and dyes, the investigation of which leads to the elucidation of the origin of colour, and serves to indicate the nature of the chemical reactions by which coloured substances may be evolved from those which are colourless.

Chemistry is popularly known as a science of far-reaching importance to specific arts, industries, and manufactures; but it occupies a peculiar position in this respect, that it is at one and the same time an abstract science, and one with an ever-increasing number of practical applications. To draw a line between the two and say where the one ends and the other begins is impossible, because the theoretical problem of to-day may reappear upon the morrow as the foundation of a valuable invention.

SECTION C.

GEOLOGY.

Opening Address by Prof. W. W. Watts, M.A., M.Sc., President of the Section.

There are two circumstances which invest the fact of my presidency of the Section this year with peculiar pleasure to myself. The first public lecture I ever gave was in the Town Hall at Birkdale in 1882, and the first of the fifteen meetings of the British Association which I have attended was that held in Southport in 1883.

There is still a third reason, that this meeting is in many respects a geological meeting. A palæobotanist is presiding over Section K, and the Council has invited, for the first time for many years, one geologist to deliver an evening discourse and another to give the address to artisans. I need hardly say that we are all looking forward to the lectures of Dr. Rowe and Dr. Flett with keen anticipation. To the one for his successful use of new methods of developing fossils and his scientific employment of the material thus prepared in stratigraphic research; to the other for his prompt, daring, and businesslike expedition to the scene of recent volcanic activity in the West Indies, during which he and his colleague, Dr. Tempest Anderson, collected so many important facts and brought away so much new knowledge of the mechanism of that disastrous and exceptional volcanic outbreak.

The Functions of Geology in Education and in Practical Life.

At the meeting in 1890, at Leeds, my old friend Prof. A. H. Green delivered an address to the Section which has generally been regarded as expressing an opinion adverse to the use of the Science of Geology as an educational agent. Some of the expressions used by him, if taken alone, certainly seem to bear out this interpretation. For instance, he says: "Geologists are in danger of becoming loose reasoners"; further he says: "I cannot shut my eyes to the fact that when Geology is to be used as a means of education there are certain attendant risks that need to be carefully and watchfully guarded against." Then he adds: "Inferences based on such incomplete and shaky foundations must necessarily be largely hypothetical."

Such expressions, falling from an accomplished mathematician and one who was such an eminent field geologist as Prof. Green, the author of some of the most trustworthy and most useful of the Geological Survey Memoirs, and above all one of the clearest of our teachers and the writer of the best and most eminently practical text-book on Physical Geology in this or any other language, naturally exercised great influence on contemporary thought. And I should be as unwise as I am certainly rash in endeavouring to controvert them but for the fact that I think he only half believed his own words. He remarks that "to be forewarned is a proverbial safeguard, and those who are alive to a danger will cast about for a means of guarding against it. And there are many ways of neutralising whatever there may be potentially harmful in the use of Geology for educational ends."

After thus himself answering what is in reality his main indictment, Prof. Green proceeds with the rest of an address crammed full of such valuable hints as could only fall from an experienced and practical teacher, showing how much could be done if the science were only properly taught. And then he concludes by asking for "that kindly and genial criticism with which the brotherhood of the hammer are wont to welcome attempts to strengthen the cornerstones and widen the domain of the science we love so well."

I think the time has now come to speak with greater confidence, and, although the distance signal stands at danger, to forge ahead slowly but surely, keeping our eyes open for all the risks of the road, with one hand on the brakes and the other on the driving gear, secure at least in the confidence that Nature, unlike man, never switches a down train on to the up track.

Those of us who have been teaching our science for any considerable time have come to realise that there are many reasons why Geology should be more widely taught than at present; that there are many types of mind to whom this science appeals as no other one does; and that there are abundant places and frequent circumstances which allow of the teaching of it when other sciences are unsuitable.

To begin with, there is no science in which the materials for elementary teaching are so common, so cheap, and everywhere so accessible. Nor is there any science which touches so quickly the earliest and most elementary interests. It was for this reason that Huxley built his new science of Physiography on a geological basis. Hills, plains, valleys, crags, quarries, cuttings, are attractive to every boy and girl, and always rouse intelligent curiosity and frequent inquiry; and although the questions asked are difficult to answer in full, a keen teacher can soon set his children to hunt for fossils or structures which will give them part of the information they seek. Of course the teaching cannot go very far without simple laboratory and museum accommodation, and without a small expenditure on maps and sections; but the former of these requirements can soon be supplied from the chemical laboratory and by the collection of the students themselves, while the latter are every day becoming cheaper and more accessible and useful. The bicycle and the camera, too, are providing new teaching material and methods, while at the same time they are giving new interests. The bicycle has already begun to create a generation to whom relief maps are not an altogether sealed book, and for whom the laws which govern the relief of a country are rapidly finding practical utility; and the camera, at the same time that it quickens the appreciation of natural beauty, must give new interest to each scrap of knowledge as to the causes, whether botanical or geological, to which that beauty is due. And it is this new knowledge which in turn develops the æsthetic sense. *Mente, manu, et malleo* sums up most of what is required in the early stages of learning; but to round off the motto we still require words to express the camera and bicycle.

Another reason is the open-airness of the practice of the science. The delight of the open country comes with intense relief after the classroom, the laboratory, or the workshop. In education generally, and especially in geological education, we have reached the end of the period when

> "all roads lead to Rome
> Or books—the refuge of the destitute."

Of course I realise fully the vital necessity of laboratory and museum work in the stages of both learning and investigation, and quite freely admit that there is an immense amount of useful work being done and to be done in these institutions alone. But what I think I do right to insist upon is that all work in the laboratory and museum must be mainly preparatory to the field-work which is to follow; every type of geological student must be sent into the field sooner or later, and in most cases the sooner the better. I have generally found that students in the early stages have a great repugnance to the grind of working through countless varieties of minerals, rocks, and fossils; but once they have gone into the field, collected with their own hands, and seen the importance of these things, and the inferences to be drawn from them, for themselves—once indeed they have got keen—they come back willingly, even eagerly, to any amount of hard indoor work.

But it is when they leave ordinary excursion work and start upon regular field training that one really feels them spurt forward. As soon as they begin to realise that surface-features are only the reflex of rock-structure and can be utilised for mapping, that to check their lines and initiate new ones they must search for and find new exposures, and that each observation while settling perhaps one disputed point may originate a host of new ones, when above all they can be trusted with a certain amount of individual responsibility and given a definite point to settle for themselves, it is then that their progress is most rapid, and is bounded only by their powers of endurance.

I have often watched my students through the various stages of their field training with the deepest interest as a study of the development of character. At first they look upon it merely as a relief from the tedium of the classroom and laboratory, and as a pleasant country excursion. But gradually the fascination of research comes over them, and as they feel their capacity increasing and their grip and insight into the structure of the country deepening, one can see them growing up under one's eyes. They come into the field a rabble of larky boys; they begin to develop into men before they leave it.

And what is true of students is more than ever true of the working geologist. I hold that every geologist, whatever his special branch may be, should spend a portion of every year in the field. Though a petrologist may have specimens sent to him from every variety, even the common ones, in a rock mass, and have their relations and proportions properly explained to him, it is quite impossible for

him to feel and appreciate these proportions and relationships so well as if he had studied and collected in the field and gained a personal interest in them. Besides this the conclusions drawn in the field are the crystalline and washed residuum, so to speak, left on the mind after the handling of dozens of specimens, weathered and unweathered, and the seeing them in a host of different lights and aspects. The rock is hammered and puzzled over and its relations studied until some conclusion is arrived at which bears the test of application to all the facts observed in the field.

Again, once a palæontologist is divorced from the field he loses the significance of minute time variations, the proportion of aberrant to normal forms, and the value of naked-eye characteristics which can be "spotted" in the field. Huxley once asked for a palæontologist who was no geologist; I venture to think we have now had enough of them. What we want above all at the present time is the recognition of such characters as have enabled our field palæontologists to zone by means of the graptolites, the ammonites, and the echinids, so that every rock system we possess may be subdivided with the same minuteness and trustworthiness as the Ordovician, Silurian, and Jurassic systems, and the Chalk.

If this is once done the biological results will take care of themselves, and we may feel perfect confidence that new laws of biological succession and evolution will result from such work, as indeed they are now doing—laws which could never be reached from first principles, but could only come out in the hands of those to whom time and place were the factors by which they were most impressed. It is only by field work that we shall ever get rid of the confusion which has been inevitable from the supposed existence of such so-called species as *Orthis caligramma, Atrypa reticularis*, and *Productus giganteus*.

As for the geological results, it is only necessary to read the excellent and workmanlike Address delivered to this Section at Liverpool in 1896 by Mr. Marr to realise how many problems of succession and structure, of distribution and causation, of ancient geography and modern landscape, are still awaiting solution by the application of minute and exact zonal researches.

On the other hand it goes without saying that the more a field geologist knows of his rocks and fossils the better will his stratigraphical work become; but this is too obvious to require more than stating.

Geology, again, is of value as a recreative science, one which can be enjoyed when cycling, walking, or climbing, even when sailing or travelling by rail. Indeed it is difficult to find a place in which to treat the confirmed geologist if you wish to make him a "total abstainer." There are others than those who must make use of their science in their professions, those in need of a hobby, those interested in natural scenery, veterans who have seen much and now have leisure and means to see more, and those fortunate ones who have not to earn their bread by the sweat of their brain or brow. Many of these have done and are doing good work for us, and many more would find real pleasure in doing so if only they had been inoculated in those early days when impressions sink deep. Mr. A. S. Reid, who has had much and fruitful experience in teaching, tells me that he has often seen seed planted in barren ground at school spring up and grow and blossom as a country-holiday recreation after schooldays, or bear the good fruit of solid research after lying dormant for many years.

We may next look upon Geology as an educational medium from quite a different point of view. If more than half the work of the man of science is the collection of fact, and of actual fact as opposed to the result of the personal equation, Geology is perhaps the very best training-ground. There are such hosts of facts to be still recorded, so many erroneous observations to be corrected, and so much hope of extending observations on already recorded facts, that there is plenty of work even for the man who can snatch but limited leisure from other pursuits and the one who is a collector of fact and nothing else, as well as those

"under whose command
Is earth and earth's, and in their hand
Is Nature like an open book."

But in the collection of facts a wise and careful selection is constantly necessary in order to pick out from the multitude those which are of exceptional value and importance in the construction of hypotheses. Nature, it is true, cannot lie; she is a perfectly honest but expert witness, and it takes an astonishing amount of acute cross-examination to elicit the truth, the whole truth, and nothing but the truth.

There is no science which needs such a variety of observations as Field Geology. When we remember that Sedgwick and Darwin visited Cwm Glas and carried away no recollection of the features which now shout "glaciation" to everyone who enters the Cwm, it is easy to see how alert must be the eyes and how agile the mind of the man who has to carry a dozen problems in his mind at once, and must be on the look-out for evidence with regard to all of them if he would work out the structure of a difficult country; and who is not only looking out for facts to test his own hypothesis, but wishes to observe so accurately that if his hypothesis gives way even at the eleventh hour his facts are ready to suggest and test its successor. There is no class of men so well up in what may be called observational natural history generally as the practised field geologist, because he never knows at what moment some chance observation—a mound, a spring, a flower, a feature, even a rabbit-hole or a shadow—may be of service to him. Not only should he know his country in its every feature and every aspect, but he must have, and in most cases soon acquires, that remarkable instinct, which can only be denoted as an "eye for a country," with which generally goes a naturalist's knowledge of its plants and of its birds, beasts, and fishes.

At the present time many educationists are in favour of teaching only the experimental sciences to the exclusion of those which collect their facts by observation. This attitude may do some good to Geology in compelling us to pay more attention to that side of our science which has been better cultivated hitherto in France than in our own country. But whether we think of education as the equipping of a scientific man for his future career or as the training of the mind to encounter the problems of life, we must admit that it would be as wrong to ignore one of the two ways only of collecting fact as it would be to teach deductive reasoning to the exclusion of that by induction. Indeed this is understating the case, for in the vast majority of the problems which confront us in everyday life the solution can only be reached if an accurate grasp of the facts can be obtained from observation. The training of the mind solely by means of experiments carefully designed to eliminate all confusing and collateral elements savours too much of "milk for babes" and too little of "strong meat for men."

Mr. Teall in his masterly Address to the Geological Society in 1901 pointed out "that the state of advancement of a science must be measured, not by the number of facts collected, but by the number of facts *coordinated*." Theory, consistent, comprehensive, tested, verified, is the life-blood of our science as of any other. It is what history is to politics, what morals are to manners, and what faith is to religion.

It is almost impossible to collect facts at all without carrying a working hypothesis to string them on. It is easy to follow Darwin's advice and speculate freely; the speculation may be right, and if wrong it will be weeded out by new facts and criticism, while the speculative instinct will suggest others. In hypothesis there will always be an ultimate survival of the fittest.

And it is not only easy but absolutely necessary, because in Geology, more perhaps than in any other science, hypotheses are like steps in a staircase: each one must be mounted before the next one can be reached; and if you have no intention of coming back again that way, it does not matter if you destroy each step when you have made use of it. Every new hypothesis has something fresh to teach, and nearly all have some element of untruth to be ultimately eliminated. But each one is a stage, and a necessary stage, in progress.

In physics and in chemistry the chief difficulties are those which surround the making of experiments. When these

have been successfully overcome the right theory follows naturally, and verification is not usually a very lengthy process. In Geology, on the other hand, theory is more quickly arrived at from the numerous facts; but the price is paid in the patience required for testing and the ruthless refusal to strain fact to fit theory. Every hypothesis leads back to facts again and again for verification, extension, and improvement.

Many of the leading conclusions of our science have not yet become part of the common stock of the knowledge of the world; indeed they are not even fully realised by many men eminent in their own sciences. The momentum given by Werner and Playfair, Phillips and Jukes, Sedgwick and Lyell, and other pioneers of the fighting science, has died down, and in the interval of hard work, detailed observation, minute subdivision, involved classification, and pedantic nomenclature which has followed, and which I believe to be only the prelude to an epoch of more important generalisation in the immediate future, it has been difficult for an outsider to see the wood for the trees. He has hardly yet realised that facts as vital to the social and economic well-being of the people at large, and conclusions of as great importance in the progress of the science and of as far-reaching consequence in the allied sciences, are being wrung from Nature now as in the past.

"The unimaginable touch of Time," the antiquity of the globe as the abode of life, the absolute proof of the evolution of life given by fossils, the proofs of change and evolution in geography and climate, the antiquity of man, the nature of the earth's interior, the tremendous cumulative effect of small causes, the definite position of deposits of economic value, the *rôle* played by denudation and earth-movement in the development of landscape, the view of the earth as a living organism with the heyday of its youth, its maturity, and its future old age and death, to mention but a few of our great principles, furnish us with conceptions which cannot fail to quicken the attention and inspire the thought of students of history, geography, and other sciences.

Now that these things are capable of definite proof, that they are of real significance in the cognate sciences, and of actual economic value, above all now that the nineteenth century, the geological century, has closed, that the heroic age is over, that we have passed the stages of scepticism and religious intolerance and reached the stage "when everybody knew it before," it might be expected that a fairly accurate knowledge and appreciation of these principles should form part of the common stock of knowledge, and be a starting-point in the teaching of allied sciences.

Another feature which adds to the attractiveness of geological observations is their immediate usefulness from many points of view. The relief and outline of any area are as closely related to its rocky framework as the form of a human being is related to his skeleton and muscles. The geological surveyor recognises how every rise and fall is the direct reflex of some corresponding difference in the underlying rocks; he seeks to observe and explain the ordinary as well as anomalous ground-features, every one of which conveys some meaning to him.

A geological basis for the classification and grouping of surface-features is the only one which is likely to be satisfactory in the end, because it is the only one founded on a definite natural principle, the relation of cause to effect. It is not without good reason that the topographic and geological surveys of the United States are combined under one management, and nowhere else are the topographic results more accurate and satisfactory. Landscape is traced back to its ultimate source, and consequently sketched in with more feeling for the country and greater accuracy of knowledge than would otherwise be possible. Geologists were among the first to cry out for increasing accuracy and detail in our Government maps, and they have consistently made the utmost use of the best of these maps as fast as they appeared. With the publication of each type of map, hachured, contoured, six-inch, twenty-five inch, the value and accuracy of geological mapping have advanced step by step. Wherever the topography is better delineated than usual, the facilities are greater for accurate geological work, and the best geological maps, and those in greatest demand, are always those based on the most minute and detailed topographic work. On the other hand geologists are training up a class of men who can read and interpret the inner meaning of these maps, and make the fullest use of the splendid facilities given by the minute accuracy of the ordnance work.

Lord Roberts has recently complained that the cadets at Woolwich are unable to read and interpret maps, and he "strongly advised them to set about improving themselves in this respect, or they would find themselves heavily handicapped in the future." I believe that the only training in this subject before entering the Royal Military Academy and the Royal Military College has been that given to those candidates who have taken up Geology for their entrance examination. By encouraging these students to study and draw maps and sections of their own districts, and to explain and draw sections across geological maps generally, thus accounting for surface-features, the examiners have compelled this small group of candidates to see deeper into a map than ordinary people. If only this training had been encouraged and advanced and made use of later, the Commander-in-Chief would have had no cause of complaint with regard to these particular men. Looking at a map is one thing; working at it, seeing into it, and getting out of it what is wanted from the vast mass of information crammed into it, is quite another; and Geology is the very best and perhaps the only means of compelling such a close study of maps as to enable students to seize upon the salient features of a country from a map as quickly and accurately as if the country itself were spread out before them. The geologist is compelled to work out and classify for himself the features he observes on his maps, such as scarps and terraces, crags and waterfalls, streams and gorges, passes and ridges, the run of the roads, canals, and railways, the nature and accessibility of the coast, and all those features which make the difference between easy-going and a difficult country. When he has worked his way over a map in this fashion that map becomes to him a real and telling picture of the country itself.

Experience, bitter experience, in South Africa has shown the necessity not only for good maps and map-reading, but for that which is the most priceless possession alike of the best field geologists and of the best strategists, a good "eye for a country." It has been said that the Boer war was a geographical war; but it was even more, and, especially in its later stages, a topographic war. Again and again the Boers aroused our astonishment and admiration by the way in which their topographic knowledge and instinct enabled them to fight, to defend themselves, and to secure their retreat by the most consummate ability in utilising the natural features of their country. This was due to two things. In the first place they took care to have with them in each part of the country the men who knew that particular district best in every detail and in every aspect. But in the second place there can be no doubt that they made the utmost use of that hunter-craft by which the majority of them could take in at a glance the character of a country, even a new one, as a whole, guided by certain unconscious principles which each man absorbed as part of his country life and hunter's training. They possessed, and had of necessity cultivated to a very high degree, an "eye for a country."

Now the study of the geology of any district, and especially the geological mapping of it, goes a long way towards giving and educating the very kind of eye for a country which is required, partly by reason of the practice in observation and interpretation which it is continuously giving, and partly because it deliberately supplies the very kinds of classification and the principles of form which a hunter-people have unconsciously built up from their outdoor experience.

Any geologist who thinks of the Weald, the wolds and downs of Eastern England, the scarps and terraces of the Pennine, the buried mountain structure of the Midlands, even the complicated mountain types of Lakeland and Wales, will remember how often his general knowledge of the rock-structure of the region has helped him as a guide to the topography; and as his geological knowledge of the area has increased he will recall how easy it has become to carry the most complicated topography in his mind, or to revive his recollection of it from a glance at the map,

because the geological structure, the anatomy, is present in his mind throughout, and the outside form is the inevitable consequence of that structure. Indeed the reading of a good geological map to the geologist is like the reading of score by a musician.

Surely it would be most unwise if the Committee on Military Education were to cut out of their curriculum the one subject which has exercised and educated this faculty, and one which is at the same time doing a great deal to counteract that degeneration of observing faculties inseparable from a town life. Some cadets at least ought to be chosen from amongst those men who have been trained by this method to see quickly and accurately into the topographic character and possibilities of a country, and provision should be made for educating their faculties further until they become of genuine strategic value.

Then I believe it would be correct to say that no class of men get to know their own country with anything like the minuteness and accuracy of the geological surveyor. The mere topographer simply transfers his impressions on the spot as quickly as may be to paper, and has no further concern with them. The geologist must keep them stored in his mind, watching the variation and development of each feature from point to point for his own purposes. He must traverse every inch of his ground, he must know where he can climb each mountain and ford every brook, where there are quarries or roads, springs or flats; what can be seen from every point of view, how the habitability or habitations vary from point to point; in short, he must become a veritable walking map of his own district. Why not scatter such men in every quarter of the globe, particularly where any trouble is likely to arise? They are cheap enough, they will waste no time, and they will be so glad of the chance for research that they will not be hard to satisfy in the matter of pay and equipment. Thus you will acquire a corps of guides, ready wherever and whenever they are wanted; and when trouble arises they may do a great deal by means of their minute knowledge of topography to save millions of money and thousands of lives, and to prevent the irritating recurrence of the kind of disaster with which we have become sadly familiar within the last five years.

In dealing with the relationship of Geology to Geography geologists are frequently charged with claiming too much. On this point at least, however, there can be no difference of opinion, that the majority of geological surveyors and unofficial investigators have kept their eyes open to this relationship, and have often contributed new explanations to old problems. They have been compelled to observe, and often to explain, surface-features before making use of them in their own mapping, and in doing so have often hit upon new principles. It is hardly needful to mention such examples as Ramsay's great conception of plains of marine denudation, Whitaker's convincing memoir on subaërial denudation, Jukes's explanation of the laws of river adjustment, Gilbert's scientific essay on erosion, Heim's demonstration of the share taken by earth-movement in the modelling of landscape features, and the exceedingly valuable proofs of the relation of human settlement and movement to underground structure, worked out with such skill and diligence by Topley in his masterly memoir on the Weald—the jumping-off place, if I may so term it, of the new geography.

No one is more pleased than geologists that geographers have ceased to draw their knowledge of causation solely from history, and that they have turned their attention to the dependence and reaction of mankind on nature as well. But while hoping that geographers will continue to study, so far as they logically can, the relationship of plants, animals, and mankind to the solid framework of the globe on which they live, we must draw the line at the invention of new geological hypotheses to explain geographic difficulties on no better evidence than that furnished by the difficulties themselves; on the other hand, we must insist that each new geological principle must take its place amongst geographic explanations as soon as it is freely admitted to be based on a sound substratum of fact.

I must confine myself to a few instances of what I mean. Mr. Marr's geological work on the origin of lake-basins has led to some remarkable and unexpected conclusions with regard to the history and origin of the drainage of the Lake district. Some of the very difficult questions raised by the physical geography of the North Riding of Yorkshire have received a new explanation from the researches of Prof. Kendall and Mr. Dwerryhouse, an explanation which is the outcome of purely geological methods of observation of geological materials. Again, the simple geological interpretation of a well-known unconformity between Archæan and Triassic rocks has made it extremely probable that many of the present landscapes, not only in the Midlands but elsewhere, may be really fossil landscapes, of great antiquity and due to causes quite different from those in operation there at the present day. In mountain regions, too, it can only be by geological observation that we shall ever determine what has been the precise direct share of earth-movement in the production of surface relief. Such examples seem to indicate that many of the principles must be of geological origin but of geographic application.

While Geology has been of direct scientific utility in topography and geography there is another domain, that of Economic Geology, which is entirely its own. The application of Geology extends to every industry and occupation which has to do with our connection with the earth on which we live. Agriculture, engineering, the obtaining of the useful and precious metals, chemical substances, building materials, and road metals, sanitary science, the winning and working of coal, iron, oil, gas, and water, all these and many more pursuits are carried on the better if founded on a knowledge of the structure of the earth's crust. Indeed a geological map of this country, showing rocks, solid and superficial, of which no economic use could be made, would be nearly blank. Yet so much has this side of the science been neglected of recent years that our only comprehensive text-books on it are altogether out of date.

But in teaching Geology as a technical science, or rather as one with technological applications, one of the greatest difficulties before us is to steer between two opposing schools, the so-called theoretical school and the practical school.

There are those who say that there is but one geology, the theoretical, and that a thorough knowledge of this must be obtained by all those who intend to apply the science. Others think that this is too much to ask—that the time available is not sufficient—and that it is only necessary to teach so much of the subject as is obviously germane to the question in hand.

The best course appears to me to be the middle one between the two extremes. If the engineer or miner, the water-finder or quarryman, has no knowledge of principles, but only of such facts as appear to be required in the present position of his profession, he will be incapable of making any improvement in his methods so far as they depend upon geology. If, on the other hand, he is a purely theoretical man without a detailed practical and working acquaintance with the facts which specially concern him, he will be put down by his colleagues as unpractical; he will have to learn the facts as quickly as he can and buy his experience in the dearest market.

It seems to me that there is certain common ground which must be acquired by all types of professional men. The general petrographic character of the common rocks, enough of their mode of origin to aid the memory, the principle of order and age in the stratified rocks, the use of fossils and superposition as tests of age, the nature of unconformities, the relation of structure to the form of the ground, the occurrence of folds and faults, and above all the reading of maps and sections, and sufficient field work to give confidence in the representation of facts on maps—these things are required by everybody who makes any use of geology in his daily life.

But when so much has been acquired it should be possible to separate out the students for more special treatment. The coal-miner will require especially a full knowledge of the coal-bearing systems, not in our own islands merely, but all over the world; a special acquaintance with the effects of folds and faults, and an advanced training in the maps and sections of coal-bearing areas. The vein-miner should be well up in faulting and all the geometrical problems associated with it, and he should have an exhaustive acquaintance with the vein and metalliferous minerals.

The water engineer needs to know especially well the porous and impervious rock types, the texture and composition of these rocks, the nature of their cements and joints, and the distribution of water levels in them. Further, he must know what there is to be known on the problems of permeability and absorption, the relation of rain to supply, the changes undergone by water and the paths taken by it on its route underground, and the varying nature of rocks in depth. He must also realise the effects of folds and faults on drainage areas and on underground watercourses, the special qualities of water-yielding rocks, of those forming the foundation of reservoir sites, and those suitable for the construction of dams.

The sanitary engineer will need to be acquainted with the same range of special knowledge as the water engineer, but will naturally be more interested in getting rid of surface water without contaminating it more than he can help than in obtaining it; he will also need a more detailed acquaintance with superficial deposits than any other class of professional men.

The quarryman and architect ought to know the rocks both macroscopically and microscopically, in their chemical and mineralogical character, their grains and their cements. But he ought to be well acquainted with the laws of bedding, jointing, and cleavage, with questions of outcrop and underground extent, and all those other characters which make the difference between good and bad stone, or between one desirable and undesirable in the particular circumstances in which a building is to be erected. Further, he should make a particular study of the action of weight and weather on the rocks which he employs.

The road engineer and surveyor, now that it has been discovered that it is cheaper and better to use the best and most lasting road-metal instead of any that happens to be at hand, requires to have an extensive acquaintance with our igneous and other durable rocks. He needs, however, not only petrographic and chemical knowledge, but also a type of information not at present accessible in England, the relative value of these rocks in resisting the wear and tear of traffic, the cementing power of the worn material, and the surface characters of roads made from them, in order that he may in each case select the stone which in his particular circumstances gives the best value for money. It would surely pay the county councils to follow, with modifications, the example of the French and Americans, and carry out a deliberate and well-planned series of experiments on all the material accessible to them in their respective districts.

The teaching of the application of Geology should therefore take some such form as the following:—First, the principles should be thoroughly taught with the use for the most part of examples drawn from the economic side; thus cementing might be illustrated on the side of water percolation, jointing from the making of mine roads and from quarry sites, faulting from effects on coal outcrops and veins, unconformity from its significance to the coal-miner; while in teaching the sequence of stratified rocks the systems and stages could be mainly individualised by their economic characters. When this is done the class must be divided into groups, each paying special attention to the points which are of essential importance to them.

The teaching at all stages should be practical and, so far as can be, experimental, and in all cases where possible a certain amount of field work should be attempted. For the field after all is the laboratory of the geologist, where he can observe experiments being made on a gigantic scale under his eyes.

The aim of the teaching should be to give to students the equipment necessary to deal with the chief geological problems that they will meet with in their varied professions; it should show them where to go for maps, memoirs, or descriptions of the areas with which they are dealing; and in cases of great difficulty should enable them to see where further geological assistance is required, and to weigh and balance the expert evidence given them against the economic and other factors of the problem before them.

From men educated thus Geology has the right to expect a valuable return. There is a vast amount of knowledge on economic subjects in existence but not readily accessible. It has been obtained by experts, and after being used is locked up or lost. And yet it is the very kind of knowledge which is wanted to extend our principles further into the economic side of the subject. So well is this recognised that many geologists are attracted to economic work mainly because of the wide range of new facts that they can only thus become acquainted with. It is possible to make use of many of these facts for scientific induction without in any way betraying confidence or revealing the source from which they are obtained; and even if they cannot be used directly they are often of great service in giving moral support, or the contrary, to working hypotheses founded on other evidence.

The knowledge of our mineral resources is of such vital consequence to ourselves and to our present and future welfare as a nation, and yet it is a matter of so much popular misconception, that I feel bound to dwell on this subject a little longer. To anyone who studies the growth and distribution of population in any important modern State the facts and reasons become as clear as day.

It is easy to construct maps showing at a glance the density of population in any country. Perhaps the most effective way to do so is to draw a series of isodemic lines and to gradually increase the depth of tint within them as the number of people per square mile increases until absolute blackness represents, say, more than 2000 people per square mile. Such maps are the best means of displaying the geography of the available sources of energy in a country at any particular period. Population maps of England and Wales in the early part of the eighteenth century would be pale in tint with a few rather darker patches, and would show a distribution dependent solely upon food as a source of energy working through the medium of mankind and animals. Such maps would be purely agricultural and maricultural, dependent upon the harvests of the land and sea. Maps made at a later period would show a new concentration round other sources of energy, particularly wind and water, but would not be perceptibly darker in tint as a whole; for although we are apt to think that we have in this country too much wind and water, they are not in such a form that we can extract any appreciable supply of energy directly from them.

But maps representing the present population, while still mainly energy maps, at once bring out the fact that our leading source of energy is now *coal* and no longer food, wind, or water. The new concentrations, marked now by patches and bands of deepest black, have shifted away from the agricultural regions and settled upon and around the coalfields. The map has now become geological.

The difference between the old and the new map is, however, not only in kind; it is even more remarkable in degree. The population is everywhere much denser. Not only are the mining and manufacturing areas on the new map more than eight times as densely populated as any areas on the older map, not only is the average population five times greater throughout the country, but the lightest spot in the new map is nearly as dark as the darkest spot on the old one. The sparsest population at the present day is as thick on the ground as it was in the densest spots indicated on the older map, while at the same time the standards of wages, living, and comfort, instead of decreasing, have increased.

The discovery of this new source of energy, coal, immediately gave employment to a much larger number of people; it paid for their food and provided the means of transporting it from the uttermost parts of the earth. Under agricultural conditions the map shows that the population attained a given maximum density, and no further increase was possible, the density being regulated by the food supply raised on the surface of the land. Our dwelling-house was but one story high. Under industrial conditions our mineral resources can support five times the number. Our dwelling-house is of five stories—one above ground and four below it.

At the same time the type of distribution is altered. The agricultural areas are now covered by a relatively scanty population, and the dense areas are situated on or near to the coal and iron fields, the regions yielding other metals, those suitable for industries which consume large supplies of fuel, and a host of new distributing centres, nodal points on the new lines of traffic, either inside the country or on

its margins where the great routes of ocean transport converge, or where the sea penetrates far in towards the industrial regions.

It has been the good fortune of this country to be the first to realise, and with characteristic energy to take advantage of, the new possibilities for development opened up by the discovery and utilisation of its mineral wealth. We were exceedingly fortunate in having so much of this wealth at hand, easy to get and work from geological considerations, cheap to transport and export from geographical considerations. So we were able to pay cash for the products of the whole world, to handle, manufacture, and transport them, and thus to become the traders and carriers of the world.

But other nations are waking up. We have no monopoly of underground wealth, and day by day we are feeling the competition of their awakening strength. Can we carry on the struggle and maintain the lead we have gained?

In answering this question there are three great considerations to keep in mind. First, our own mineral wealth is unexhausted; secondly, that of our colonies is as yet almost untouched; and thirdly, there are still many uncolonised areas left in the world.

The very plenty of our coal and iron, and the ease of extracting it, has been an economic danger. There has been waste in exploration because of ignorance of the structure and position of the coal-yielding rocks; waste in extraction because of defective appliances, of the working only of the best-paying seams and areas, of the water difficulty, and the want of well-kept plans and records of areas worked and unworked; waste in employment because of the low efficiency of the machinery which turns this energy into work. With all this waste our coalfields have hardly yielded a miserable *one* per cent. of the energy which the coal actually possesses when *in situ*.

Engineers and miners are trying to diminish two of these sources of waste, and Geology has done something to reduce that of exploration. This has been done by detailed mapping and study, so that we now know the areas covered by the coal-seams, their varying thickness, the "wants," folds, and faults by which they are traversed, and all that great group of characters designated as the geological structure of the coalfields. It could not have been accomplished unless unproductive as well as productive areas had been studied, the margins of the fields mapped as well as their interiors, and unless the geological principles wrested from all sorts of rocks and regions had been available for application to the coal districts in question. We no longer imagine every grey shale to be an index of coal; we are not frightened by every roll or fault we meet with underground; nor do we, as in the past, throw away vast sums of money in sinking for coal in Cambrian or Silurian rocks.

We cannot afford, hard bitten as we are in the rough school of experience and with our increased knowledge, to make all the old mistakes over again, and yet we are on the very eve of doing it. Up to the present it is our visible coalfields that we have been working, and we have got to know their extent and character fairly well. But so much coal has now been raised, so much wasted in extraction, and so many areas rendered dangerous or impossible to work, that we cannot shut our eyes to the grave fact that these visible fields are rapidly approaching exhaustion. The Government have done well to take stock again of our coal supply and to make a really serious attempt by means of a Royal Commission to gauge its extent and duration; and we all look forward to that Commission to direct attention to this serious waste and to the possibility of better economy which will result from the fuller application of scientific method to exploration, working and employment.

But we still have an area of concealed coalfields left, possibly at least as large and productive as those already explored and as full of hope for increased industrial development. It is to these we must now turn attention with a view of obtaining from them the maximum amount possible of the energy that they contain. The same problems which beset the earlier explorers of the visible coalfields will again be present with us in our new task, and there will be in addition a host of new ones, even more difficult and costly, to solve. In spite of this the task will have to be undertaken, and we must not rest until we have as good a knowledge of the concealed coalfields as we have of those at the surface. This knowledge will have to be obtained in the old way by geological surveying and mapping and by the coordination of all the observations available in the productive rocks themselves and in those associated with them, whether made in the course of geological study or in mining and exploration. But now the work will have to be done at a depth of thousands instead of hundreds of feet, and under a thick cover of newer strata resting unconformably on those we wish to pierce and work. When we get under the unconformable cover we meet the same geology and the same laws of stratigraphy and structure as in more superficial deposits, but accurate induction is rendered increasingly difficult by the paucity of exposures and the small number of facts available owing to the great expense of deep boring. How precious, then, becomes every scrap of information obtained from sinkings and borings, not only where success is met with, but where it is not; and how little short of criminal is it that there should be the probability that much of this information is being and will be irretrievably lost!

Mr. Harmer pointed out in a paper to this Section in 1895 that under present conditions there was an automatic check on all explorations of this kind. The only person who can carry it out is the landowner. If he fails he loses his money and does not even secure the sympathy of his neighbours. If he succeeds his neighbours stand to gain as much as he does without sharing in the expense. The successful explorer naturally conceals the information he has acquired because he has had to pay so heavily for it that he cannot afford to put his neighbours in as good a position as himself and make them his rivals as well; while the unsuccessful man is only too glad to forget as soon as possible all about his unfortunate venture. And yet in work of this kind failure is second only to success in the value of the information it gives as to the underground structure which it is so necessary to have if deep mining is to become a real addition to the resources of the country.

Systematic and detailed exploration, guided by scientific principles, and advancing from the known to the unknown, ought to be our next move forward: a method of exploration which shall benefit the nation as well as the individual, a careful record of everything done, a body of men who shall interpret and map the facts as they are acquired and draw conclusions with regard to structure and position from them—in short a Geological Survey which shall do as much for Hypogean Geology as existing surveys have done for Epigean Geology, is now our crying need. Unless something of this sort is done, and done in a systematic and masterful manner, we run a great risk of frittering away the most important of our national resources left to us, of destroying confidence, of wasting time and money at a most precious and critical period of our history, and of slipping downhill at a time when our equipment and resources are ready to enable us to stride forward.

We do not want to be in the position of a certain town council which kept a list of its old workmen and entered opposite one, formerly sewerage inspector, that he possessed "an extensive memory which is at the disposal of the corporation."

Even supposing the scheme outlined by Mr. Harmer cannot be carried out in its complete form, a great deal will be done if mining engineers can receive a sufficient geological training to enable them to realise the significance of these underground problems, so that they can recognise when any exploration they are carrying out inside their own area is likely to be of far-reaching geological and economic significance outside the immediate district in which they are personally and immediately concerned.

Turning to our colonies it is true that in many of them much is being done by competent surveys to attain a knowledge of mineral resources, but this work should be pushed forward more rapidly, with greater strength and larger staffs, and above all it should not be limited to areas that happen to be of known economic value just at the present moment. It is almost a truism that the scientific principle of to-day is the economic instrument of to-morrow, and it will be a good investment to enlarge the bounds of geological theory, trusting to the inevitable result that every

new principle and fact discovered will soon find its economic application. Further, it is necessary that we should obtain as soon as possible a better knowledge of the mineral resources of the smaller and thinly inhabited colonies, protectorates, and spheres of influence. This is one of the things which would conduce to the more rapid, effective occupation of these areas.

With regard to areas not at present British colonies, it seems to me that no great harm would be done by obtaining, not in any obtrusive way, some general knowledge of the mineral resources of likely areas. This at least seems to be what other nations find it worth their while to do, and then, when the opportunity of selection arises, they are able to choose such regions as will most rapidly fill up and soonest yield a return for the private or public capital invested in them.

To sum up, I consider that the time has come when geologists should make a firm and consistent stand for the teaching of their science in schools, technical colleges, and universities. Such an extension of teaching will of course need the expenditure of time and money; but England is at last beginning to wake up to the belief, now an axiom in Germany and America, that one of the best investments of money that can be made by the pious benefactor or by the State is that laid up at compound interest, "where neither rust nor moth doth corrupt," in the brains of its young men.

This knowledge has been an asset of monetary value to hosts of individuals who have made their great wealth by the utilisation of our mineral resources, and to our country, which owes its high position among the nations to the power and importance given to it by its coal and iron. It is surely good advice to individuals and to the State to ask them to reinvest some of their savings in the business which has already given such excellent returns, so that they and we may not be losers through our lack of knowledge of those sources of energy which have made us what we are, and are capable of keeping for many years the position they have won for us.

And in our present revival of education it would be well that its rightful position should be given to a science which is useful in training and exercising the faculty of observation and the power of reasoning, which conduces to the open-air life and to the appreciation of the beautiful in nature, which places its services at the disposal of the allied sciences of topography and geography, which is the handmaid of many of the useful arts, and which brings about a better knowledge and appreciation of the life and growth of that planet which we inhabit for a while, and wish to hand on to our descendants as little impaired in vitality and energy as is consistent with the economic use of our own life-interest in it.

NOTES.

THE following have been elected Fellows of the Reale Accademia dei Lincei:—As Ordinary Fellows ("Soci nazionali"), Messrs. J. Dalla Vedova for geography, A. Naccari for physics, C. de Stefani for geology, A. Borzi, J. Fano, A. Maffucci for zoology, pathology, &c. As Corresponding Fellows ("Corrispondenti"), Messrs. P. Pizzetti for mechanics, A. Angeli for chemistry, R. Fusari and A. Stefani for zoology and physiology. As Foreign Fellows, Messrs. D. Hilbert and J. D. van der Waals for mathematics and mechanics, J. Thomson and H. Becquerel for physics, R. Lydekker for geology and palæontology, E. B. Wilson, T. Schlösing, P. Sorauer and F. Marchand for zoology, agronomy and pathology.

THE prizes offered by the Reale Accademia dei Lincei for the present year have been allotted as follows:—Royal prizes have been awarded to Prof. Artini for mineralogy and geology, to Prof. Ghino Valenti for social and economic science, and to the late Prof. Contardo Ferrini for jurisprudence and political science. Of the prizes offered by the Minister of Public Instruction, awards have been made for physical and chemical science to Profs. Cicconetti and Pierpaoli (jointly), and to Prof. Baggio Lera, and for philology to Profs. Toldo, G. Tàmbara and V. Ussani. The Carpi prize for botany has been conferred on Dr. Biagio Longo, of Rome. The award of the Royal prize for mathematics has been deferred.

WE have received a copy of the programme of prizes to be awarded in 1904 by the Société Industrielle de Mulhouse. The present publication takes the place of all previous issues, and copies of the programme, in which certain changes have been made, can be obtained on application to the secretary of the society. There are no fewer than fifty-six competitions concerned with chemical technology, more than twenty dealing with the mechanical arts, and twelve with natural history and agriculture. Several prizes are offered with the object of improving and stimulating local industries. The programme also contains full particulars of several large prizes of five thousand francs, which are awarded for scientific work at intervals of in some cases ten, and in others five years.

THE death is announced, at the age of eighty-one years, of the Rev. Maxwell Henry Close, treasurer of the Royal Irish Academy, and author of numerous contributions to the *Proceedings* of the Royal Irish Academy.

VIOLENT earthquake shocks of seventeen seconds' duration are reported by Reuter to have been experienced in Bucharest, Roumania, at 10 a.m. on Sunday last.

AN earthquake is stated in the *Globe* to have taken place in Lisbon at 1.34 p.m. on Monday last. It was of three seconds' duration.

DR. W. H. ALLCHIN is to deliver the Harveian oration at the Royal College of Physicians of London on Monday, October 19. The Bradshaw lecture (the subject of which will be "Some Observations on Tuberculosis of the Nervous System") will be delivered at the college by Dr. E. F. Trevelyan on Thursday, November 5.

A COURSE of lectures on bacteriology for medical men, veterinary surgeons, agriculturists, brewers, farmers, sanitary inspectors, teachers and others is to be given by Dr. F. Bushnell at Plymouth under the direction of the education authority for that town. The lectures will be illustrated by lantern slides, cultures and demonstrations, and it is hoped to make arrangements for a class of practical bacteriology in the future.

AN International Exhibition of Inventions is to be held at Brighton in November next. The object of the exhibition is to afford inventors and patentees an opportunity of bringing their inventions before the notice of capitalists, manufacturers, and users. Awards of gold, silver, and bronze medals will be made for inventions possessing the greatest merit combined with commercial utility.

IT has been decided to start a school of colonial medicine at Marseilles, and Surgeon-Major Martine, of the colonial military service, has just been appointed by the French Minister of War to confer with the municipality of Marseilles relative to its establishment.

THE U.S. Consul-General at Frankfort is reported by the *Chemist and Druggist* to have stated that "the city of Düsseldorf will soon have the first academy for practical medicine in Germany, and it will be in connection with the new hospital to be erected." Prof. Witzel, of the University of Bonn, is proposed as director of the academy. The establishment of other similar academies is under consideration.

An exposition is to be held in Baltimore under the auspices of the Maryland Public Health Association and the Tuberculosis Commission appointed by the Governor of that State, the object of which is to arouse public and professional interest in the subject of tuberculosis. The basis for the exposition will, says the *Lancet*, be the investigations of the Tuberculosis Commission into the cause, the prevalence, and the distribution of human tuberculosis in that State, its influence on the public welfare, and the best methods of restricting and controlling the disease. The medical questions involved, the importance of habits, occupation, and housing conditions will receive consideration. The ultimate purpose of the exposition is to determine the proper legislation, municipal, State, and national, to be recommended, some definite line of prophylaxis, as well as measures relating to the care and cure of both advanced and incipient cases of pulmonary tuberculosis.

It is stated in the *British Medical Journal* that a number of consumptive patients have been taken by Dr. Kuss, of Paris, to the Vallot Observatory, near the summit of Mont Blanc, for the purpose of ascertaining the effect of rarefied air on their lungs. The patients remain in the open for the greater part of the twenty-four hours in every kind of weather.

The next meeting of the International Congress of Ophthalmology is to take place at Lucerne from September 19 to 21 of next year, under the presidency of Prof. Dufour. According to the official circular which has recently been distributed, no papers are to be read, but such, if written in English, French, German, or Italian, and sent with the admittance fee before May 1 next to Prof. Mellinger, of Basle, will be printed and grouped according to their subjects, and this printed report will be sent to each member with his admission card at least two weeks before the date appointed for the opening of the congress. At the meetings the authors of the papers will have the opportunity of stating the conclusion of their respective papers in a few words, and the discussion will then commence. Members present who are interested in the subject of the paper will, of course, have had the opportunity of reading the paper before the opening of the congress. The discussions will be printed and published at the close of the congress, and possibly papers received too late to be printed before the opening of the congress will also be discussed and printed with the discussions. The afternoons of the congress will be devoted to practical demonstrations.

The Paris Society of Pharmacy is to celebrate its centenary on October 17, and in connection with it an historical account of the Society has been prepared and will be read by Prof. E. M. Bourquelot, the general secretary, at a public meeting. This history, together with other original matter that may be supplied by members of the Society, will, says the *Chemist and Druggist*, form the material of a book which will be published later. The work will also contain the portraits and biographies of leading pharmacists and chemists who have been connected with the Society, such as Nicolas Houël, the founder, the "Citizen" Trusson, one of the last directors of the Free Society of Pharmacists, Parmentier, Vauquelin, Bouillon-Lagrange, and others.

A meeting was recently held in America, under the chairmanship of Dr. D. C. Gilman, to promote a proposed memorial to the late Major Reed, M.D., well known for his work in connection with the discovery of the mode by which yellow fever has been spread, and the suppression of the disease. According to *Science* the meeting decided that an effort should be made to raise a memorial fund of 25,000 dollars or more, the income to be given to the widow and daughter of Dr. Reed, and that after their decease the principal shall be appropriated either to the promotion of researches in Dr. Reed's special field, or to the erection of a memorial in his honour at Washington.

Particulars, according to the *Lancet*, have been received of the medical results of the expedition of investigation to the Bahamas which was sent out some time ago by the Johns Hopkins University and the Baltimore Geographical Society, from which we glean the following. Skin diseases, and especially leprosy, were found to be very prevalent. No effort is made to prevent the spread of leprosy, and many instances were noted where persons suffering from that disease were engaged in the sale of provisions, in piloting vessels, and in other pursuits. No cases of yellow fever were discovered, and but two cases of malaria were recognised. Many species of mosquito were secured for subsequent study. A special feature of the work of the medical department was the study of the degenerates of Abaco, descendants of the Torys, who closely intermarry.

According to the *Times* a prehistoric British barrow has just been opened at Martinstown, Dorset. The barrow contained worked flints, a quantity of pottery, and a large British urn inverted on a slab of stone, covering some cremated remains which had been wrapped in a rough material of cloth or rushes, the texture of the weaving of which was still traceable. In another barrow close by have been found a vase and a bronze knife with a portion of a willow handle.

On this day week, September 10, a storm of unusual violence advanced over the central portion of the British Islands, causing enormous damage in its passage over sea and land. The *Daily Weather Report* issued by the Meteorological Office for 8h. a.m. of that day showed that a depression lay to the westward of the Irish coasts; by 6h. p.m. the disturbance reached the Irish Sea, and had advanced at the rate of about fifty miles an hour, while by the evening it had spread over nearly the whole country. So rapid was its rate of progression that the *Daily Weather Report* of the morning of September 11 showed that the centre of the storm had reached the north of Holland. The destruction was so general that it seems somewhat invidious to refer to individual instances. We merely quote two cases to illustrate its violence—the demolition of the solid breakwater at Dover, and the uprooting of trees in the vicinity of London that had withstood the storms of a hundred years. During the passage of the gale the barometer fell at the unusual rate of more than 0·1 inch an hour. The velocity of the wind to the southward of the centre of the storm was much greater than to the northward; near the mouth of the Channel on the evening of September 10 it reached nearly 70 miles an hour. The rainfall measured in the twenty-four hours ending on Friday exceeded an inch and a half in the north-west, and an inch and a quarter in the east of England.

The September issue of the Meteorological Office pilot chart contains, in addition to the twelve maps showing the tidal streams round the British Isles, a reproduction of Dr. Hermann Berghaus's chart of cotidal lines round our own and the North Sea coasts, with explanatory remarks by Prof. G. H. Darwin. To render the information more complete to the mariner, there is a table giving the times of high water at Dover throughout the month. Another addition deals with a proposal to alter the steamship route between the Bristol Channel and Jamaica. A comparison has been

instituted to show the merits and demerits of the Great Circle track, 3524 miles; the Rhumb track, 3603 miles; and the suggested route *viâ* the Azores and the Mona passage, 3722 miles. The conclusion arrived at is that, "taking into consideration the wind direction, the wind force, and the sea-surface currents, it seems safe to assume that the Azores routes will be covered by a vessel at her usual speed in an interval of time certainly not greater than that occupied by the same ship in following either the Great Circle route or the Rhumb track, and probably in less."

The report of the Meteorological Commission of Cape Colony for the year 1901 shows a considerable falling off as regards the number of stations, compared with that of the previous year, owing to the difficulties of observation and communication under the operation of Martial Law within the colony. Nevertheless, the commission has been able to publish rainfall statistics from 436 stations, excluding those connected with the Kenilworth Observatory, and a large amount of valuable general meteorological observations. Many of the stations destroyed or discontinued were situated in the more sparsely populated districts, and it is estimated that it will take years to recover the lost ground. The commission reports, however, that there is an awakening sense of the importance of meteorology among the governing bodies of the other British South African territories, and that, in spite of the troublous times recently passed through, the prospects of the development of meteorological observations are much brighter now than ever they have been. We wish the commission success in the continuation of its very useful operations.

Particulars are given in the *Scientific American* of an ingenious invention which has been brought out to notify automatically the outbreak of fire, and to indicate to the fire stations the name and position of the building which is in danger. Of the device, which is the invention of M. Emile Guarini, the essential feature is a thermometer which is so arranged that it is capable of releasing a toothed wheel which serves to transmit the requisite information. When the heat reaches the thermometer and the mercury rises in the tube until it reaches the mark indicated by 42° on the Réaumur scale it touches a small platinum wire inserted in the upper end of the tube, and thereby closes an electric circuit including an electro-magnet. Thus excited the magnet attracts and holds its armature. This motion releases a toothed wheel of peculiar construction, which, by means of a weight or spring, is made to revolve, and produces during each revolution a series of makes and breaks upon a contact piece placed in its path. A connected induction coil describes the exact location of the endangered property to the neighbouring fire station, where the message is registered by a Morse apparatus, and the attention of the attendants is directed by an electric gong to the signal received. An incandescent lamp also glows when the alarm is sounded.

It will not be owing to want of help from the Imperial Department of Agriculture if West Indian planters fail to get profitable returns from their land. In the last number of the *West Indian Bulletin* the value of ground nuts, Eucalyptus trees, and the bay tree is brought to notice. Mr. W. G. Freeman has collected much practical information on the subject of ground nuts, known also as monkey nuts and pea nuts. Besides furnishing oils of which the best grades are nearly equal to olive oil, the ground nut, *Arachis hypogaea*, offers another source of profit, since it may be manufactured into oil-cake, for which there is evident demand, as at the present time large quantities are imported. For the manufacture of bay oil and bay rum the tree *Pimenta acris* has a considerable value; it is indigenous to many of the islands, but must be distinguished from the tree known as "bois d'Inde citron" in Dominica, the product from which is inferior.

Judging from a circular which has been received from the Forestry Bureau of the U.S. Department of Agriculture the lumbermen of the United States of America do not yet thoroughly recognise that their interests coincide with those of the forester. Of the three papers included in the circular, the first is an address delivered by President Roosevelt in which he states that "the forest problem is in many ways the most vital internal problem in the United States." Chief-forester Pinchot discusses the mutual position of the lumberman and the forester.

We have received a chart of fossil shells found in connection with the seams of coal and ironstone in north Staffordshire, drawn up by Dr. Wheelton Hind and Mr. J. T. Stobbs. There are columns showing the strata met with in the Potteries and Cheadle coal-fields, but the information relates chiefly to the former and more important district. The species figured are chiefly Mollusca, and they are arranged alongside the divisions which they characterise. The chart is published by the North Staffordshire Institute of Mining and Mechanical Engineers, and it should prove of practical use to mining students and to those engaged in sinking for coal.

Dr. J. F. Whiteaves has described some additional fossils from the Cretaceous rocks of Vancouver, and has given a revised list of the species therefrom, in the fifth and concluding part of his first volume on Mesozoic fossils (Geol. Survey of Canada, August). A number of Crustacea, of Cephalopoda and other Mollusca, and Brachiopoda are figured. Echinoderms are represented only by fragments, and corals and Polyzoa by two or three specimens. A few fish-remains occur, including *Lamna appendiculata*, which extends through the Upper Cretaceous strata, and ranges from northern Europe to New Jersey and Queensland.

Dr. Ernest W. Skeats contributes an essay on the chemical composition of limestones from upraised coral islands, with notes on their microscopic structure (*Bull.* Museum Comp. Zool., Harvard Coll., vol. xlii.). The rocks consist of true coral reefs and of fragmental strata made up of organic débris. The author, after describing the materials, briefly discusses the relation of the distribution of magnesium carbonate in the limestones to the question of the origin of dolomite. It seems probable that the introduction of magnesium into the rocks takes place from the waters of lagoons under certain favourable conditions.

In addition to his presidential address on the distribution of life in the Antarctic, Dr. H. Woodward contributes a paper on East Anglian geology to the *Transactions* of the Norfolk and Norwich Naturalists' Society for 1902–1903.

We have received two parts of the *Bulletin International* (Rospravy Ceske Ak. Praze) for 1903. Among their contents, reference may be made to an important article, by Dr. O. Völker, on the development of the pancreas in the amniote vertebrates, and to a second, by Prof. J. Janošík, on that of the blood corpuscles in the same great group.

A lengthy illustrated account of the "Bathymetrical Survey of the Fresh-water Lochs of Scotland" appears in the current *Geographical Journal*, the introductory portion of which gives the history of the origin of the survey; this is followed by particulars of some six of the lochs. The *Geographical Journal* is to publish the bathymetrical maps

and the other observations of the survey staff, and the series of articles will, it is hoped, when completed, form a worthy memorial of the late Mr. F. P. Pullar.

THE September issue of the *American Journal of Science* contains, as frontispiece, a process portrait of Prof. J. Willard Gibbs, and an obituary notice of Prof. Gibbs by Prof. H. A. Bumstead. The number also contains an article by Mr. J. Stanley Gardiner, of Cambridge, on "The Origin of Coral Reefs as shown by the Maldives."

THE September issue of the *Popular Science Monthly* (New York) is full of interesting matter, and contains, among other contributions, articles on "Palm and Sole Impressions and their use for Purposes of Personal Identification," by Prof. H. H. Wilder; "Theories of Sleep," by Dr. P. G. Stiles; "Mosquitoes and Suggestions for their Extermination," by W. L. Underwood; and part iv. of a series of articles by Prof. J. A. Fleming, F.R.S., on "Hertzian Wave Wireless Telegraphy."

MESSRS. WATTS AND CO. have issued, for the Rationalist Press Association, a reprint, at sixpence, of the first edition of "The Origin of Species." It will be remembered that an edition of the final form of this great classic was brought out not long ago by Mr. Murray in paper covers at one shilling.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mr. C. Pells; two Masai Ostriches (*Struthio camelus*, var. *massaicus*) from East Africa, presented by Mr. A. Marsden; two Grey-breasted Parrakeets (*Myopsittacus monachus*) from Monte Video, presented by Mr. C. Martin; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, two Mozambique Monkeys (*Cercopithecus pygerythrus*) from East Africa, a Black-striped Wallaby (*Macropus dorsalis*), a Black-tailed Wallaby (*Macropus walabates*), a Rufous Hare Wallaby (*Lagorchestes hirsutus*) from New South Wales, two Black-headed Caiques (*Caia melanocephala*) from Demerara, an Australian Barn Owl (*Strix delicatula*), a Winking Owl (*Ninox connivens*), a Burton's Lizard (*Lialis burtoni*), a Limbless Lizard (*Pygopus lepidopus*) from Australia, a Javan Loris (*Nycticebus javanicus*) from Java, two Grey Monitors (*Varanus griseus*) from North Africa, two Muricated Lizards (*Amphibolurus muricatus*) from Australia, deposited.

OUR ASTRONOMICAL COLUMN.

SEARCH-EPHEMERIS FOR COMET 1896 v. (GIACOBINI).—Herr M. Ebell contributes to No. 3898 of the *Astronomische Nachrichten* a second portion of the ephemeris for comet 1896 v. which he commenced in No. 3881 of the same journal. This ephemeris takes as the time of perihelion June 22·5, 1903, but Herr Ebell also gives ephemerides in which the time of perihelion passage is taken as June 6·5 and July 8·5 respectively.

Ephemeris 12h. M.T. (Berlin). T=June 22·5 1903.

1903	α (h. m. s.)	δ (° ′)	log r	log Δ	Brightness.
Sept. 26	4 4 43	+14 12·2	0·2492	0·0177	2·66
,, 30	4 5 48	+13 29·7			
Oct. 4	4 6 9	+12 45·0	0·2604	0·0111	2·61
,, 8	4 5 47	+11 59·0			
,, 12	4 4 45	+11 12·2	0·2717	9·9973	2·64
,, 16	4 3 4	+10 24·9			
,, 20	4 0 49	+9 37·8	0·2831	0·0076	2·39
,, 24	3 58 3	+8 51·4			
,, 28	3 54 51	+8 6·5	0·2943	0·0130	2·21

INTENSITY OF SPECTRAL LINES.—*Circular* No. 72 of the Harvard College Observatory is devoted to the explanation of a scheme, proposed by Prof. Pickering, for the formation of a uniform universal method of recording the absolute intensities of spectral lines.

Comparative intensities are easily determined, in the case of bright lines by the bolometric method, in the case of dark lines by using the bright background as the standard unity intensity. Absolute values, however, are much more difficult to determine, and two methods offered themselves to Prof. Pickering's choice. First, the determination once for all of the intensities of certain well-known lines; secondly, the construction of an artificial standard with which all lines might be directly compared; he decided to use the second method.

A standard scale was constructed in which each line was 1·26 times as wide as the one next below it, so that the logarithms of their widths differed by 0·1, and the scale was then reduced rather more than twenty times and printed on sensitised paper, the haziness, which is characteristic of real spectral lines, being produced by inserting various thicknesses of white paper between the negative and the sensitive paper.

To standardise this prepared scale the line E of the Fraunhofer spectrum on Higgs's charts was used, and the intensities of thirty-six lines between λ 5261·8 and λ 5276·2 were measured, on the scale, on five different charts, and the five independent scale readings, their mean, the residuals from the mean and the width of each line in Ångström units, are given in the table accompanying Prof. Pickering's paper.

A PROVISIONAL CATALOGUE OF VARIABLE STARS.—No. 3 vol. xlviii. of the Harvard College Observatory *Annals* is devoted to a provisional catalogue of variable stars in which reference is made to some 1227 different variables. The catalogue has been prepared from a card-index of variable stars, commenced by Prof. W. M. Reed in 1888, and carried forward by Miss A. J. Cannon since 1900, which now contains about 34,000 cards referring to observations of variables.

A new notation has been adopted after grave consideration in this catalogue. Each star is designated by a number containing six figures, which are printed in ordinary type if the star is in the northern hemisphere and in italics if it is in the southern. The first two figures give the hours and the second two the minutes in the R.A., whilst the last two give the degrees in the declination; thus the designation of the first star in the catalogue (V. Sculptoris) is *000339* which, when translated, gives the approximate position of the star as R.A.=0h. 3m., Dec.=−39°.

The catalogue also gives the Chandler number, the name of the star or its constellation, the D.M. number, the exact position for 1900, the chief particulars of the elements, the class of the variable and of its spectrum, and the date of discovery, with the name of the discoverer, for each variable.

MASS OF MERCURY.—In No. 3897 of the *Astronomische Nachrichten*, Prof. T. J. J. See, of Washington, gives the results of his recomputation of the mass of Mercury, and points out, *en passant*, the importance to workers in celestial mechanics of obtaining the truest possible value of this constant.

The latest measurements of the planet's diameter have slightly increased the former values, and Prof. See adopts 6″·00 as the most probable value of the diameter at unit distance; this gives an absolute diameter of 4351±72km. and a resulting mass of $m=1:14868548\pm743427$, which Prof. See adopts as the definite value. The mean specific gravity of the planet, with this mass, is 3·09, and this conforms very well with the other densities obtaining in the solar system.

CORRECTIONS TO EXISTING STAR CATALOGUES.—Since the publication of the "Catalogue of Reference Stars in the Zone +46° to +55°," by the Royal Observatory of Catania, Signor G. Boccardi has discovered a number of errors in various existing catalogues. These are set forth and their corrections given in a paper communicated by him to No. 3898 of the *Astronomische Nachrichten*; they include errata in the coordinates and in the precessional corrections.

Twelve catalogues are dealt with, including, among others, "The Radcliffe Catalogue of 6317 Stars (1845·0),"

"The Brussels Catalogue of 10,792 Stars (1865·0)," "The Harvard College Catalogue of 8627 Stars, A.G. Zone +50° to +55°" (Leipzig, 1892), and "The Bonn Catalogue of 18,457 Stars (1875·0), A.G. Zone +40° to +50°," published at Leipzig in 1894.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—An examination for a geographical scholarship of the value of 60*l.* will be held on Wednesday, October 14. Candidates, who must have taken honours in one of the final schools of the university, should send in their names to the reader in geography not later than Thursday, October 1. The scholar elected will be required to attend the full course of instruction at the School of Geography during the academic year 1903–4, and to enter for the university diploma in geography in June, 1904.

DR. F. H. NEWMAN, principal of the Carlisle Technical School and director of higher education in that city, has been appointed principal of the Norwich Technical Institute and organiser of higher education.

IT is stated in *Science* that a gift of ten thousand dollars has been made to Washington and Lee University by Mrs. Cyrus H. McCormick and her three sons, of Chicago, the interest of which sum is to be devoted to the development of the department of physics. A new laboratory of engineering and physics, the gift of an anonymous donor, is expected to be ready for occupation in the summer of next year.

THE evening continuation schools in connection with the School Board for London reopened on September 14. As the School Board will cease to exist after the end of April next the present session will be the last under the Board. Among the numerous classes arranged we notice that doctors and nurses will teach first aid and home nursing in upwards of two hundred schools. There will also be facilities for women and girls to learn practical cookery, dress-cutting and making, and laundrywork, and for men and boys to receive instruction in woodwork. The lantern will, in many cases, be used to illustrate the lessons in geography. The Board has arranged for medical men to give simple lectures on health in twenty schools; the subjects will include the air and ventilation, the house, prevention of consumption, the care of the skin, personal hygiene, how to prevent the spread of infectious disease, the care of infancy and childhood, ill-health in women, &c.; all the lectures will be illustrated by diagrams, and many simple experiments will be shown by the lecturers.

THE Board of Education, South Kensington, has issued the following list of candidates successful in the 1903 competition for the Whitworth scholarships and exhibitions:—Scholarships, 125*l.* a year each (tenable for three years), John S. Nicholson, Alford, Aberdeenshire; Leonard Southerns, Retford, Notts.; Alec J. Simpson, Edinburgh; Alexander Gray, Edinburgh. Exhibitions, 50*l.* (tenable for one year), Frederick G. Turner, Southsea; James Cunningham, Banbury; William Welch, London; Edmund W. Spalding, Lincoln; William E. Hogg, London; Alfred R. Stamford, Plumstead, Kent; Joseph Lloyd, Pembroke Dock; John A. Davenport, Liverpool; Stewart S. Spears, Sheerness-on-Sea; James Lees, Southsea; William H. Powell, London; Edwin C. Trew, Landport, Portsmouth; Frederick W. B. Sellers, Sutton, Surrey; John E. Lister, Doncaster; Richard W. Bailey, Manor Park, Essex; Laurence H. Pomeroy, London; Christopher J. Lees, London; Fred Newell, Plumstead, Kent; Edmund G. Nicholls, Swansea; Maurice K. Pedlar, East Stonehouse, Devon; George F. Sutherland, Aberdeen, N.B.; Charles I. Sutton, Plumstead, Kent; Robert H. Barr, Barrow-in-Furness; William H. Hemer, Devonport; James Nicol, Barrhead, N.B.; Frederick E. Pollard, Eastwood, Notts.; Arnold Sykes, Huddersfield; Wilfred C. Kimber, London; Henry F. Elliott, Plumstead, Kent; David Richardson, Crewe.

THE following list of successful candidates for royal exhibitions, national scholarships, and free studentships (science), 1903, has been issued by the Board of Education, South Kensington:—Frederick G. Turner, Southsea; James M. Mackintosh, Inverness, N.B.; Samuel Lees, Broughton, Manchester; John H. Hugon, Eccles, Manchester; Arthur A. Rowse, Southsea; William E. Hogg, London; William L. Perry, Plymouth, royal exhibitions; Archibald Ward, Sheffield; Alexander Gray, Edinburgh; Edwin S. Crump, Wolverhampton; Leslie G. Milner, New Brompton, Kent; Archibald R. Richardson, London; Francis G. Steed, Devonport, national scholarships for mechanics (group A); Harold H. Broughton, Huddersfield; George F. Sutherland, Aberdeen, N.B., free studentships for mechanics (group A); William H. L. Patterson, Chiswick; Arthur E. Hall, Swindon; William F. G. Swann, Brighton; James Hoggarth, Bath; John Watson, Sunderland, national scholarships for physics (group B); Charles I. Robinson, London, free studentship for physics (group B); Frederick Dewhurst, Middleton Junction, Manchester; William Godden, Canterbury; George S. Whitby, Hull; John F. Stansfield, Morley, Leeds; Henry Holmes, Middlesbrough; Thomas Jackson, Middlesbrough, national scholarships for chemistry (group C); Frederic W. Caton, Hove, Sussex; John Keegan, Burnley, free studentships for chemistry (group C); Edward Hindle, East Bierley, Bradford; Ethel Mellor, Burnley, national scholarships for biology (group D); Ellis L. Jones, Blaenau Festiniog, free studentship for biology (group D); Winifred M. Clune, Bristol; Fred Thistlethwaite, Burnley; Diogo F. de Souza, London, national scholarships for geology (group E).

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 7.—M. Albert Gaudry in the chair.—Parthenogenesis of the larvæ of Asteriæ by the action of carbonic acid, by M. Yves **Delage**. By modifying the conditions, the larvæ develop to the stage when all the essential organs are well marked.—On the production of glycogen in fungi cultivated in weak sugar solutions, by M. Émile **Laurent**. The production of reserve carbohydrates is related both in fungi and in vascular plants to a food supply containing an abundance of sugar or analogous substances. The author has discovered an interesting exception to this rule, four species of moulds, *Mucor racemosus, Sclerotinia Libertiana, Botrytis cinerea,* and *Saccharomyces cerevisiae*, all giving considerable quantities of glycogen when grown in very dilute organic solutions.—Observations of the planet MA (August 24, 1903) made at the Observatory of Besançon, by M. P. **Chofardet**.—On a bacterial disease of tobacco, "chancre" or "anthracnose," by M. G. **Delacroix**. This disease is due to a bacillus, not previously described, and to which the name of *Bacillus oeruginosus* is given, on account of the coloration it develops in certain culture media.

CONTENTS.

THURSDAY, SEPTEMBER 24, 1903.

PLANT PHYSIOLOGY.

A Text-book of Plant Physiology. By George James Peirce, Ph.D. Pp. iv + 285. (New York: Henry Holt and Co., 1903.)

THE author's object is to present "the main facts of plant physiology and the saner hypotheses regarding them, striving to express safe views rather than to echo the most recent . . . and everywhere trying to avoid giving the impression that the science, or any part of it, has reached ultimate knowledge and final conclusions." The standard adopted is to treat the subject "less exhaustively than Pfeffer's 'Handbuch,' and more fully than Noll's section of the Bonn text-book."

This, though doubtless an admirable object, is one not easy to attain, and the result, it must be confessed, is a book of unequal merit. As an instance of the author at his best may be mentioned the section (p. 72) on "Root-tubercle Plants." The six pages devoted to the matter give a clear and readable account which should suffice for the needs of the moderately elementary student. On the other hand, the final section of the same chapter—that on the ash constituents—is unsatisfactory. The student gets from it neither a clear conception of what is meant by the essential constituents of the mineral food-supply nor a knowledge of the more interesting details. For instance, the reader is not even directed by references to Schimper's work on oxalates in reference to the assimilation of nitrates. It is possible that the author does not consider this to be one of the "saner hypotheses," but in that case it might have been discussed with a caution.

When the author deals with photosynthesis the result is better, and there is much to interest the reader. The chief fault in his presentment of the subject is that he does not fully face the relation between the photosynthetic activity of different parts of the spectrum and the absorption bands of the chlorophyll spectrum. This is a fundamental point, and should be discussed in a treatise such as the present.

Dr. Peirce's style might here and there be mended. Take, for instance, the following sentence (p. 43), with which photosynthesis is introduced:—

"The source of carbon for all organisms except the nitrogen bacteria and plants containing chlorophyll or its apparent equivalent physiologically, bacteriopurpurin, is, directly or indirectly, these colour-containing plants."

The chapter (p. 103) on the "absorption and movement of water, &c.," is not uniformly good. The student will learn from it if he has the gift of picking out what is best, but we fear that he will not get to the root of the matter. This part suffers especially from the author's plan of not in general describing methods of research. It seems to us impossible to give a clear or interesting view of the problem of water-transport without a more direct appeal to experiment. Thus, in the section on "the means of transfer of nutrient solutions" (pp. 116–124), we miss an account of the fundamental fact that a cut branch in a glass of water is a self-regulating mechanism, in which absorption is practically equal to loss by transpiration. It is only at p. 141 that we get the idea briefly stated without proof.

Chapters v., vi. and vii. are respectively devoted to growth, irritability, and reproduction. It is doubtless a difficult matter to give an adequate account of irritability in such a book as the text-book before us, but when full allowance has been made for such difficulty, there remains a good deal to which exception must be taken.

We miss a general statement of the widely accepted view according to which a plant (like an animal) is guided by certain definite irritabilities strictly comparable to the senses of animals.[1] It seems to us clear that Dr. Peirce's views do not harmonise with the modern conception of irritability. Thus, in speaking (p. 213) of heliotropic curvatures, he asserts that the bending of a stem towards the light is the mechanical result of the increased growth-rate on the shady side of the stem. He thus ignores the well-known fact that the growth-rate of apheliotropic organs is also increased by darkness, a result fatal to his point of view. It is depressing to find this way of looking at heliotropism (which we had hoped was dead and buried) once more to the fore.

In some matters of fact we cannot agree with the author's statements. Thus at p. 214 we read:—

"So much more does gravity influence the direction of growth of roots that the influence of light is scarcely apparent until all parts are uniformly subjected to gravitation by means of the clinostat."

The student who has grown mustard seedlings in a glass of water and exposed them to one-sided illumination will read the above statement with surprise. Elsewhere the author's treatment of the action of light and gravitation is singularly confused, if not downright wrong. Thus (p. 214) we read that the direction of growth of leaves is a resultant of two forces, gravity and light, in illustration of which he describes leaves assuming a normal light position while slowly rotated on the clinostat, the whole point of the experiment being in reality to prove that the normal light position may be assumed in response to light alone, and not as a compromise between sensitiveness to light and gravitation.

On the whole, we think the part on irritability suffers from the attempt to crowd too much into the available space. The student would gain if less detail were attempted, and a simpler, broader treatment adopted.

What we have said of one section may be perhaps applied to the book as a whole. A reader with a power of selection will be able to make use of it, and he will find much that is not to be obtained from ordinary English text-books.

F. D.

[1] Brief and partial statements occur at pp. 206 and 207.

THE MINERAL RESOURCES OF THE FRENCH COLONIES.

Les Produits Coloniaux d'Origine Minérale. By Prof. Laurent. Pp. viii + 352. (Paris: Baillière, 1903.) Price 5 francs.

THIS little work forms one volume of the "Colonial Library," which is a small series of four-shilling books dealing with the animal, vegetable, and mineral products of the French colonies, as well as with the question of hygiene. It is divided into two chapters; the first briefly describes the geology of each colony and enumerates its various mineral products; in the second, each useful mineral is taken in its turn, and the sources of supply in each colony are discussed.

The book would have been improved by a summary, giving at a glance a general idea of the mineral wealth of the French possessions. This I have endeavoured to supply so far as official information is available.

Mineral Output of the French Colonies and Protectorates, 1901.

Mineral	Algeria		French Guiana		Indo-China		Madagascar		New Caledonia		Tunis		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	Metric Tons.	£	Kilos.	£	Metric Tons	£	Kilos.	£	Metric Tons	£	Metric Tons	£	Metric Tons	£
Brown Coal ...	213	102	—	—	—	—	—	—	—	—	—	—	213	102
Coal	—	—	—	—	248,622	12,431[1]	—	—	—	—	—	—	248,622	12,431[1]
Chrome Ore ...	—	—	—	—	—	—	—	—	17,451	37,840	—	—	17,451	37,840
Clay	119,195	17,040	—	—	—	—	—	—	—	—	—	—	119,195	17,040
Cobalt Ore ...	—	—	—	—	—	—	—	—	3,123	16,600	—	—	3,123	16,600
Copper Ore ...	7,267	5,035	—	—	—	—	—	—	1,088	3,960	—	—	8,355	8,995
Flags	8,350	3,424	—	—	—	—	—	—	—	—	—	—	8,350	3,424
Gold	—	—	4,021	434,320	—	—	1,045	112,860	—	—	—	—	kils 5,066	547,180
Gypsum... ...	600	60	—	—	—	—		—	—	—	—	—	600	60
Iron Ore ...	514,473	198,679	—	—	—	—	—	—	—	—	—	—	514,473	198,679
Lead Ore ...	1,614	4,383	—	—	—	—	—	—	—	—	8,200	26,760	9,814	31,143
Limestone ...	27,000	25,500	—	—	—	—	—	—	—	—	34,800	29,635	61,800	55,135
Nickel Ore ...	—	—	—	—	—	—	—	—	132,814	297,400	—	—	132,814	297,400
Onyx	294	3,352	—	—	—	—	—	—	—	—	—	—	294	3,352
Phosphate of Lime	265,000	212,000	—	—	—	—	—	—	—	—	172,375	105,700	437,375	317,700
Plaster	34,740	26,397	—	—	—	—	—	—	—	—	12,984	24,078	47,724	50,475
Potter's Clay ...	—	—	—	—	—	—	—	—	—	—	6.375	300	6,375	300
Salt	18,518	15,995	—	—	2,502	4,050	—	—	—	—	16,900	14,880	37,920	34,925
Sand and Gravel	86,727	3,774	—	—	—	—	—	—	—	—	—	—	86,727	3,774
Stone, Building	798,560	73,744	—	—	—	—	—	—	—	—	873,805	61,251	1,672,365	134,995
,, Rough	1,436,250	56,550	—	—	—	—	—	—	—	—	—	—	1,436,250	56,550
Zinc Ore	26,913	52,704	—	—	—	—	—	—	—	—	17,900	43,240	44,813	95,944
Total ...	—	698,739	—	434,320	—	16,481	—	112,860	—	355,800	—	305,844	—	1,924,044

[1] Estimated.

The total value of all the minerals produced by the French colonies is about 2 millions sterling, of which Algeria claims more than one-third. The mineral wealth of this colony is derived mainly from its iron ore and phosphate of lime; French Guiana is the largest gold producer; New Caledonia is famous for its nickel ore; and Tunisia is coming into notice on account of its phosphatic deposits.

The growing importance of the phosphate industry of northern Africa is worthy of notice, indeed, this mineral comes second in order of value in the table. The author gives some interesting details concerning the phosphatic beds at Gafsa, from which nearly all the phosphate of Tunisia is obtained. The mineral was not discovered at Gafsa until 1885, and the concession for working it was not obtained until 1896. Since that date the French have constructed a railway 156 miles long, from the port of Sfax to the centre of the mining district, and it is expected that the output for 1903 will be about 300,000 tons. The phosphatic beds occur in rocks of Lower Eocene age; the principal seam now being worked at Gafsa is 11 ft. 6 ins. thick, and contains 60 per cent. of tribasic phosphate of lime.

In spite of being full of valuable information, Prof. Laurent's book is unsatisfactory, because he has introduced much matter which is entirely out of place under the title chosen for the volume. But in his preface he tells us that the book is a *résumé* of his lectures to young men who propose to go to the colonies, and that he wishes them to know something of the modes of occurrence and methods of treatment of minerals in other countries, so that they may be able to take advantage of the possible resources of new districts. He consequently enters into details which make parts of the book into a jumble of geology, mineralogy, prospecting, mining, quarrying, dressing, smelting, salt-making, &c. There is no royal road to learning, and the attempt to teach in one course of lectures what in reality requires at least four separate courses should certainly be discouraged. And there are other grounds for complaint; the figure of a sulphur-still is very antiquated, and, if my memory serves me aright, it appeared in my French lesson books half a century ago. I doubt very much whether this old form is ever used now; at all events, it is very different from the "doppioni" which were employed for treating the sulphur rock in the Romagna in the early 'seventies. The picture of the modern kiln does not give the proportions of an ordinary Sicilian "calcarone." Other second-hand figures have been picked up and inserted here and there with little advantage to the reader. Nothing could well be worse than the figure of a blast-furnace, and a student unacquainted with Blake's stone-breaker would fail to understand its action by

reference to the illustration. It is true this is well lettered, but no explanation is furnished as to what each letter denotes. Many of the figures prepared specially for the book from photographs are of little use.

In a word, the book would have been more acceptable if the author had confined his attention to the matters really included in the title, and had supplied better illustrations.

EXPERIMENTAL SCIENCE FOR BEGINNERS.

Practical Chemistry. By Walter Harris, M.A., Ph.D. Vol. i. Measurement. Vol. ii. Exercises and Problems. Vol. iii. Qualitative and Quantitative Analysis. Pp. x+91; ix+172; vii+146. (London: Whittaker and Co., 1903.)

THERE are probably few teachers, who, with half-a-dozen pupils and plenty of time to devote to them, would not prefer the oral to the book process of imparting the elements of experimental science. Yet when the number in a class is large, and laboratory work is limited to one or two hours a week—the usual order of things in schools—the demonstrator must be relieved by the aid of some form of printed instructions.

In compiling a book of this kind, the chief difficulty which presents itself is to know how much to tell about the processes, and how much to leave to the pupil's intelligence and initiative.

Given the budding philosopher and plenty of time, very little book direction is necessary, and he may safely be left to worry out details for himself. The everyday youth is not a philosopher, and if, in addition, he has only one hour a week in the laboratory, he must be helped to his results in a very substantial manner, to enable him not only to absorb a variety of facts in the time at his disposal, but (and this is equally important) to avoid the discouraging consequences of repeated experimental failures. These points have been recognised in the three little volumes which together make up Dr. Harris's "Practical Chemistry." Vol. i. deals really with elementary physics, and contains exercises in measurement of length and volume, mass and density. Vol. ii. contains easy qualitative and quantitative experiments in chemistry. The third volume contains the elements of qualitative and quantitative analysis, in reference to which the author laconically remarks that "for those who do not require this section for examination purposes, it should be omitted." The experiments in the first two volumes are numerous, simple, and suggestive, and well adapted for a school laboratory, and there are many things which will be found of value to the teacher as well as to the student.

One feels compelled to differ from the author on the subject of illustrations. The author says: "The omission of all illustrations of apparatus is a new departure." Is it a good one? We must remember that the beginner does not recognise by name even "the permanent apparatus commonly seen in laboratories," and although it is very desirable that "the student should be encouraged to devise his own apparatus," it is a process which is certain to result in failure and loss of time. Those who have attempted with all the knowledge of laboratory resources to reduce an apparatus to a simple form, will recognise how troublesome the process is. Moreover, the author gives no directions for working glass; which, one would suppose, would be the first step in fitting up glass apparatus.

May one further suggestion be offered? Experiment 1, in section ii., on homogeneous and heterogeneous substances, is not a single experiment at all, but a very condensed account of the separation of solids and liquids, in which filtration, sublimation, levigation, and fractional distillation are discussed in turn. This and some other chapters would be improved by dividing them up and by giving, in addition to general principles, a description of specific instances, from which the teacher might make his own selection.

There is no doubt that these volumes will form a useful addition to the modern literature on science teaching. J. B. C.

OUR BOOK SHELF.

Untersuchungen über Amylose und Amyloseartige Körper. By O. Bütschli. (Heidelberg: Carl Winter, 1903.)

THIS pamphlet of about 100 pages is a reprint from the *Proceedings* of the Heidelberg Association for Natural History and Medicine (vol. vii. part iii.), which is one of the best known of the German scientific societies. It illustrates a tendency, not infrequently seen in Germany, to utilise the pages of a journal for the issue of what is practically a book. The author, Prof. Bütschli, is well known to students of biology for his work on protoplasm, and distant as the subject of starch may at first appear from zoological studies, the present research is a direct outcome of the former. The microscopic investigation of various colloids occurring in nature which led Bütschli to his well-known hypothesis of the foam-like structure of protoplasm caused him later to direct his attention to the formation of starch grains, cellulose membranes and the like in the vegetable world. Some years ago he published his view that starch grains are of the nature of sphæro-crystals. From this he passed on to attempt to prepare starch grains artificially from starch solutions, and he was rewarded by the discovery that, under certain conditions, especially on evaporating a solution containing also 5 per cent. of gelatin, particles differing but slightly from natural starch grains are deposited. These results were criticised by Arthur Meyer, who expressed the opinion that these particles consisted not of starch, but of amylodextrin. The present pamphlet is a reply to these criticisms, and on the ground of various chemical reactions the conclusion is finally reached that Meyer was wrong, and the author right in his original contention.

This is the gist of the monograph, and its length is due to the fact that it became necessary for the author to make a chemical investigation of various starches, dextrins, and allied carbohydrates in order to justify his main conclusions.

From the purely chemical standpoint very little real progress is contributed to our knowledge of the carbohydrates. The sugars, thanks to Fischer and others, we now know something about, but concerning the

molecular size and constitution of the heavy carbohydrates, like starch and glycogen, and the family of dextrins intermediate between these and the sugars, we have at present little more than guesses to go upon. To give, as the present author does, long lists of reactions with iodine and other reagents, and on the strength of differences in these to describe as separate substances amylose, amylosan, amylodextrin, and other forms of dextrin, and to add to the list amyloporphyrin and amylorubin, does not really advance matters much. Bütschli apologises at the start for his lack of chemical knowledge, and in the end admits that several of his preparations are mere mixtures; we therefore fear that, from the chemists, his work will meet with but scant courtesy. He has nevertheless succeeded in producing a very readable little brochure, and if his main contention is accepted, his labours will not have been useless.

Lessons on Country Life. By H. B. M. Buchanan and R. R. C. Gregory. Pp. xi+330. (London: Macmillan and Co., Ltd., 1903.) Price 3*s.* 6*d.*

ONE of the authors of the above book, Mr. H. B. M. Buchanan, produced a little time ago two small "Country Readers," most excellent books for the children of a rural elementary school, in which our common domestic animals were discussed from a full knowledge in an easy, pleasant style. We are sorry we cannot give the same praise to the "Lessons" before us; the educational value of the former book has disappeared, and the authors have allowed a craving for completeness to swamp their judgment, so that the result is a miniature and scrappy encyclopædia instead of a book.

Country life is a vast subject, so vast that no child can learn during his school life even a fraction of the information it may be desirable he should possess in his after life; the teacher, then, must abandon the attempt to impart information, but devote his energies to instilling into his pupils the right way of looking at things, the method which they can employ themselves when going about the world. The method consists in a training in observation and experiment. Here instead we have first a sort of abbreviated text-book on live stock, hints on breeding and feeding, twelve breeds of cattle described at lengths varying from a page down to two lines, horses, sheep and pigs to correspond, analyses of milk, rules for making butter and cheddar cheese; with such a programme what chance is there of observation or experiment for school children?

The latter portion of the book deals with common birds and mammals in a much better spirit; strike out the unnecessary Latin names for orders, families and species, and it forms a fair reading book. The last section, on insects, is again spoiled by a wholly unnecessary passion for classification; classification is only grammar, and the parts of τυπτω are just as good in this way as "Coleoptera, Euplexoptera, Orthoptera, Thysanoptera, &c." We know by sad experience how easy the schoolmaster finds it to write these things on the blackboard and make his class copy them with due attention to neatness and spelling; observation and experiment require both labour and thought. We grieve to speak unkindly of Mr. Buchanan, who has done such excellent work before; there are good things in the book, *e.g.* the section on poultry and the illustrations, but, like the curate's egg, it is only good "in parts." If the new teaching on country life is to succeed in our schools, it will be in virtue of the spirit, and not of the information which the teacher imparts to his pupil, and we consider that this book fatally misses the spirit.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Radio-activity and the Age of the Sun.

IN the Appendix E of Thomson and Tait's "Natural Philosophy," Lord Kelvin has computed the energy lost in the concentration of the sun from a condition of infinite dispersion, and argues thence that it seems "on the whole probable that the sun has not illuminated the earth for 100,000,000 years, and almost certain that he has not done so for 500,000,000 years. As for the future, we may say, with equal certainty, that inhabitants of the earth cannot continue to enjoy the light and heat essential to their life for many million years longer, unless sources now unknown to us are prepared in the great storehouse of creation."

The object of the present note is to point out that we have recently learnt the existence of another source of energy, and that the amount of energy available is so great as to render it impossible to say how long the sun's heat has already existed, or how long it will last in the future.

The lost energy of concentration of the sun, supposed to be a homogeneous sphere of mass M and radius a, is $\frac{3}{5}\mu M^2/a$, where μ is the constant of gravitation. On introducing numerical values for the symbols in this formula I find the lost energy to be $2{\cdot}7\times 10^7$ M calories, where M is expressed in grammes. If we adopt Langley's value of the solar constant this heat suffices to give a supply for 12 million years. Lord Kelvin used Pouillet's value for that constant, but if he had been able to use Langley's his 100 million would have been reduced to 60 million. The discrepancy between my result of 12 million and his of 60 million is explained by a conjectural augmentation of the lost energy to allow for the concentration of the solar mass towards its central parts. I should have thought the augmentation somewhat too liberal, but for the present argument it is immaterial whether it is so or not.

Now Prof. Rutherford has recently shown that a gramme of radium is capable of giving forth 10^9 calories. If, then, the sun were made of such a radio-active material it would be capable of emitting 10^9 M calories without reference to gravitation. This energy is nearly forty times as much as the gravitational lost energy of the homogeneous sun, and eight times as much as Lord Kelvin's conjecturally concentrated sun.

Knowing, as we now do, that an atom of matter is capable of containing an enormous store of energy in itself, I think we have no right to assume that the sun is incapable of liberating atomic energy to a degree at least comparable with that which it would do if made of radium. Accordingly, I see no reason for doubting the possibility of augmenting the estimate of solar heat as derived from the theory of gravitation by some such factor as ten or twenty.

In an address to Section A of the British Association in 1886 I discussed the various estimates which have been made of geological time, and I said, "Although speculations as to the future course of science are usually of little avail, yet it seems as likely that meteorology and geology will pass the word of command to cosmical physics as the converse." I think the recent extraordinary discoveries show that this forecast was reasonable.

It is probable that the bearing of radio-activity on the cosmical time-scale has occurred to others, but I do not happen to have seen any such statement.

Cambridge, September 20. G. H. DARWIN.

The Principle of Radium.

WOULD some of your readers inform me whether the case of the radium phenomena is quite unique? When a small magnet in my drawer has been ready to act on a compass at any time during the last twenty years, and has not

altered its appearance in any appreciable way, I ask whence comes the continuous magnetic supply?

Again, when a lady has had for a great many years a cedar work-box which has never failed in its characteristic odour, it is a natural question to ask, whence comes the smell? The statement in books, both of physics and physiology, is that something material is given off from the wood which alights on the olfactory membrane of the nose. This is purely gratuitous, as the statement is without a shadow of proof, the box being to all appearances in no way diminished in size or otherwise altered. If the hypothesis, for it is nothing more, fails, how does the case differ in principle from that of radium? S. W.

Normally Unequal Growth as a Possible Cause of Death.

I HAVE found from a good many years' experience that it is frequently difficult to assign any definite cause of death to the lower Vertebrata which die in the Zoological Society's Gardens from time to time. The examination of a large example of the Japanese salamander (*Megalobatrachus japonicus*), which lived for a good many (nineteen) years here, and measured some three feet in length, has suggested to me a rather curious and truly "natural" cause of death—if my inferences be correct. The animal showed no obvious signs of disease in any organ. Judging from its length it must have been old, for a specimen three feet long is asserted to have been at least fifty-two years old (*vide* Gadow, Cambridge Natural History, "Amphibia and Reptiles," p. 99). Comparing this specimen with one some twenty inches in length I found that the size of the heart, as of the other organs, was, as might be expected, actually larger, but that all the subdivisions of the heart were of the same proportions in the two animals. But in the course of a dissection of the heart it was plain that the two series of valves, which lie respectively at the anterior and at the posterior end of the pylangium, were so small, relatively speaking, that, when forced backwards by the pressure of blood in the entire conus arteriosus, they would not meet in the middle line. On the other hand, in the smaller salamander the three valves in question were in the first place situated closer together than in the large animal, being nearly in actual contact, and in the second place their size was so great in relation to the diameter of the pylangium that they would—or, I should rather say, could—meet after the systole of the ventricle. The fact is that these valves do not appear to grow *pari passu* with the general increase in size of the heart and the conus arteriosus. My own observations as to the small size of the valves in the large example are quite in accord with those of Hyrtl (*Cryptobranchus japonicus*, Vindobonae, 1865), who dissected an animal two and a half feet in length, and figures the valves, incorrectly as I believe in some particulars, but correctly in representing them to be of small relative size. It might be suggested, therefore, that the imperfection of the circulatory mechanism necessarily caused by the condition of the valves would lead to serious disturbances, and perhaps to death. If so the animal has a term put to its life by the mere fact that, while the heart grows with the increase in bodily size, the semilunar valves of the conus arteriosus do not.

FRANK E. BEDDARD.

Zoological Society's Gardens, London, N.W.

Can Carrier-pigeons Cross the Atlantic?

COULD any of your readers give me an answer to this query? It is stated in the London *Standard* (April 20, *circâ*) that this feat was accomplished in 1886, when three out of nine American carrier-pigeons set free in London returned to their home-huts. I have hitherto been unsuccessful in getting the authority for this particular experiment. From the points of view of bird migration and of seed dispersal, it is a query of considerable importance.

H. B. GUPPY.

21 Henleaze Gardens, Westbury, Bristol, September 21.

A TECHNICAL SCHOOL FOR THE HIGHLANDS OF SCOTLAND.

THE difficult problem of catering for the educational needs of remote and isolated rural districts has been dealt with practically in this country by such enlightened benefactors as the Countess of Warwick in her school at Bigods, near Dunmow, in Essex, which has been carrying on its useful work for some five years, and which is now about to be made still more strictly into a school of agriculture, so as to bring it into harmony with the requirements of the district and of the counties which it serves. Lady Warwick's sister, the Duchess of Sutherland, has faced the still more difficult problem of providing a technical school for the Highlands of Scotland, and a preliminary account of the first scheme was given in these columns at the time of its inception (NATURE, vol. lxv. p. 106, December 5, 1901). The work thus set going by Her Grace was formally inaugurated on September 8 by Lord Balfour of Burleigh, Secretary for Scotland, at a public ceremony held for the purpose of laying the memorial stone. The building, the design of which is by Mr. Dick Peddie, of Edinburgh, is already several feet above its foundations, and is situated on the picturesque slope of a hill overlooking the little town of Golspie, on the shore of Dornoch Firth, and within two miles of the beautiful grounds of Dunrobin Castle, the Scottish home of the Sutherlands. The main features of the educational scheme, as set forth in the statement published in our first notice, have been adhered to, but the details of a curriculum suitable for requirements of such a very diverse nature as have to be met in this remote Highland district can only be worked out by actual experience—it will be a case, as Lord Balfour said at the meeting, of *solvitur ambulando*. How diverse these conditions are will be realised when it is pointed out that the industries which have to be catered for are agriculture, almost entirely of the "crofting" type, textiles and dyeing, small mechanical trades and handicrafts, and fishing.

The ceremony on September 8, rendered picturesque by the surroundings and by the great gathering of some 2000 people from the neighbourhood and from all the towns and villages served by the Highland Railway from Inverness northwards, was opened by the singing of the Hundredth Psalm, and by a prayer for the success of the undertaking by Archdeacon Sinclair. The gathering was in itself a memorable one, the Duke of Sutherland, who presided, being supported by the Duchess and their family, by the Duke and Duchess of Portland, Mr. Andrew Carnegie and his partner Mr. Henry Phipps, Mr. R. B. Haldane, K.C., M.P., Prof. Meldola, by representatives of nearly all the leading Scottish families, by Members of Parliament, Provosts and Sheriffs, the Principals of the Scotch universities, the chairman of the governors of the Glasgow and West of Scotland Technical College, the conveners of the county councils, and by educationists of every class, including professors and inspectors of schools. Mr. James Macdonald, W.S. of Edinburgh, the hon. secretary of the school committee, had made himself responsible for the organisation of the meeting, which was in every way successful. After the laying of the stone, Lord Balfour said in the course of his speech:—

"This is to be a school for Sutherland and these other counties (Caithness, Ross and Cromarty). It is not only to be accessible to Sutherland and these other counties, as any other school might be, but it is a school expressly designed for the needs and wants of the district in which we are met. Its curriculum will be based on a careful study of the condition of things as they now exist, and will have, as the promoters

clearly indicate, a direct reference to the special wants and wishes of those in the district around it. I think I am not wrong in claiming for this departure on the part of its promoters that it is to be a new fact in the educational history of our country . . . this school is not merely a copy—still less is it intended to be a rival of other educational agencies and institutions, whether they be of an elementary or of a higher or secondary type . . . it is an intelligent effort and a new attempt to solve a difficult problem, and one which never was more difficult than it is to-day, as to whether you can, in regard to any given population, living under certain given conditions, which perhaps cannot in the district be much altered, give education and ameliorate for them those conditions, and if so, what kind of education will best do it . . . in this matter the promoters have set themselves not to consider codes or grants or examination successes."

In view of the fact that the Sutherland Technical School is entirely due to private enterprise, and is therefore in the same position as regards support from public sources as Lady Warwick's school in Essex, it will be of importance to those interested in this phase of recent educational development to give another extract from Lord Balfour's speech:—

"This school is an experiment, a highly desirable and promising experiment, but not one on which any local authority could itself venture. Nor could the Education Department do it, much as we approve of the proposal. It is work for private initiative, for private enterprise, and for individual enthusiasm. May I just say in passing that if we remodel our educational system, as I for one sincerely hope we shall do, that we bring it up to date, and that we make it more complete than it is at present, let us leave some place for free individual action. Boards, committees and departments are all very well in their way, but they are apt to be regulative rather than initiative, critical rather than constructive. Many advances in education must start outside the established system. Do not let us keep private institutions out of that system. Widen your local powers if you like. Let them take advantage of and help those institutions outside their own system which are well managed. In the present instance, as I understand, the local authority—the technical committee of the county—has promised a considerable measure of support, and under the freer conditions of State recognition that have obtained in recent years, we do not anticipate there will be any difficulty in our helping them. What the exact measure of that support may be, and on what conditions it is given, it is difficult to say until the plan of the school work becomes more defined; but I can give you this assurance with every intention of seeing it carried out, that the progress of the school will be watched with interest and sympathy by the officials of my department, and that as large a measure of support will be accorded it as the conditions laid down by Parliament for supporting education will allow."

In moving a vote of thanks to Lord Balfour, the Duchess of Sutherland, in the course of an admirable speech, made some remarks so thoroughly in harmony with the views of the advocates of the newer education that they may appropriately be transferred to these columns:—

"It has been suggested that in Scotland the old system of what is called classical education is sufficient to meet all requirements; that the secondary departments of the primary schools are fairly equipped, and that if a boy wishes to pursue so-called technical studies he might be awarded a sum of money to enable him to go into large cities and there pursue them. It has even been suggested that essentially a rural agricultural school must in its aims be opposed to mental culture. Such ideas are fallacies. I am afraid that the studies of the immortal wonders of the classics and of what are so strangely called the deal languages have too often proved a dead study to the student. A mere mechanical acquisition of knowledge leads us nowhere. How would Aristophanes, author of the "Birds" and the "Clouds," how would Hesiod, the poet of the husbandman, how would Theocritus and Virgil, singers of pastoral delights, turn in their graves if they could know that only their dog-eared books spoke their music to our children, and that the chords from which that music sprang were unassayed, unloved, even unnoticed by the scholars of to-day. Not, indeed, that the children will not notice, and that they cannot love, but the present time education has, until very recently, driven them away from the region of growth to the region of the cut and dried. They live in this inspiring country at an age when the swelling of the grain on the hillside, the habits of the birds, the marvellous nature of a handful of earth, might rouse a passionate interest and quicken every faculty of observation. In a school such as this we would draw culture from its source until the youth, who for himself has seen and understood, should turn away from the intoxication of his own experiments to the books of those who long ago saw and understood, and there find a background for his own ideas and an echo to his conclusions. I deny . . . that there is any divorce between these imaginations and the practical conditions of to-day. . . . This is a scientific age; that is why we need the scientific schools. Every hour fresh marvels of the mysterious nature which surrounds us are being by science revealed."

The Duke of Portland, in seconding the vote of thanks, dwelt forcibly upon the point that the new school would not in any way compete with or overlap the work of existing institutions. A vote of thanks to the donors of the building fund, the Duke of Sutherland and Mr. Andrew Carnegie, was proposed by Mr. R. B. Haldane, M.P., and seconded by Sheriff Guthrie, who in the course of his speech pointed out the immense amount of harm that had been done to the cause of education in this country by certain classes of writers and speakers whose sole function had been to act the part of destructive critics without making any constructive contributions of any kind. Mr. Carnegie replied on behalf of the donors.

The school thus launched is intended to accommodate forty residential pupils and a limited number of day pupils from the immediate neighbourhood. The building will contain fifty-six rooms, of which fourteen are to be used as class-rooms, laboratories, and workshops. The cost of erection and equipment is estimated at 16,000*l.*, of which 8000*l.* have been contributed by the Duke of Sutherland and 8000*l.* by Mr. Carnegie. The Duke of Portland and many others interested in the district have also given substantial aid. Forty bursaries of 30*l.* each have been given by the Duchess of Sutherland, Mrs. Carnegie, and many other generous friends of the movement. The site of the school has been given by the Duke of Sutherland. The educational experiment which the enlightened zeal of the Duchess of Sutherland has now set going in the extreme north merits the warmest sympathy of our readers and of all who have the cause of scientific education at heart. The undertaking is unquestionably a bold one, and if, as Lord Balfour intimates, it is to be left solely to private enterprise in this country to initiate this kind of work, it is a matter of congratulation that we have among us such enthusiasts as the noble sisters whose names will always be associated with the cause of scientific education in rural districts. The school at Golspie will be unique of its kind in the north of Scotland. The Highlander by temperament and the surroundings of his birth, by

the excellence of his primary education and by the natural zeal which he possesses for the acquisition of knowledge is certain to rise to the opportunity now to be placed in his way. It is unnecessary to institute comparisons, but it may be safely said that this Highland school will have raw material to deal with of which many an English rural district might well be envious.

RESIN-TAPPING.

CRUDE resin is almost always obtained from pines of various species, *e.g.* *Pinus Pinaster* or *P. maritima* in Europe, *P. palustris*, *P. Taeda* and *P. australis* in America, and *P. longifolia*, *P. excelsa*, &c., in India. It may also be obtained from other Conifers

Fig. 1.—Cup and Gutters used in collecting Crude Turpentine.

(spruce, larch, &c.), and even from some Dicotyledons. The universal practice is to cut through the cortex and to allow the crude viscous liquid oleo-resin to drip into some form of receptacle, *e.g.* a hole in the sandy soil, or an excavated "box" in the foot of the bole, or a metal or earthenware "pot" hung on to the tree.

From the crude resin thus obtained, numerous other products are derived by means of distillation, &c. Among these spirits or oil of turpentine, colophany (rosin), pitch and tar are the most important, and the quantities of these substances required annually for naval purposes, for making varnishes, sealing-wax, &c., are so great that the resin industry is a large and lucrative one.

There are certain limits to the working of a pine-tree as a resin-factory which increase the expense of production so considerably that it has long been the practice in America recklessly to abandon a tract worked for resin and push forward into newer regions. These limits of production depend especially on the fact that cutting large holes in the basal parts of the bole of a tree is bound to result in disaster sooner or later; and since the American plan systematically pursued has been that of "boxing"—*i.e.* cutting large holes in the wood below, into which the resin from the cut and scarified cortex should slowly drain—the inevitable result has been the wholesale destruction of the trees by means of rot-fungi, wind throwing, ground fires, &c.

This state of affairs has naturally driven the authorities to seek for some better methods of extracting the resin, and in a recent publication[1] Dr. Hertz brings forward the results of a very complete set of experiments designed to compare the yield and value of the resin obtained by the old "boxing" method, and that obtained by a modification of the European systems.

The latter consists in allowing the resin from the periodically scarified cortex and young wood to drain down into two slanting spouts of thin tin, which direct it into a pot hung properly beneath. The advantages claimed for the improved system are, a longer life of the tapped tree, a greater yield of resin all the time, less waste in catching the resin, diminished evaporation of volatile products, and less dirt and discoloration as the liquid flows over the face exposed, as well as other and minor points.

These matters, expressed in terms of money value, are given in a series of tables, from which the following is one extract only:—

Half crop.	From dip.	From scrape.	Total.	Excess.
Second year.	Dollars.	Dollars.	Dollars.	Dollars.
Cups	266.34	49.25	315.59	144.13
Boxes	104.51	66.95	171.46	—
Third year.				
Cups	171.27	27.44	198.71	132.65
Boxes	39.49	26.57	66.06	—
Fourth year.				
Cups	167.33	29.23	196.56	132.56
Boxes	36.09	27.91	60.00	—

The bulletin is admirably written, and affords an excellent example of what may be done by a properly trained expert in learning the methods of an old industry practised in another country, improving and adapting them to the wants of his own locality, and, above all, in demonstrating his points so convincingly by means of experiments that the most prejudiced of his workmen becomes reconciled to the innovations.

The illustrations, of which we select one, are well chosen, sufficient, and admirably executed.

THE SOUTHPORT MEETING OF THE BRITISH ASSOCIATION.

THE Southport meeting of the British Association was concluded as we went to press last week. At the meeting of the General Committee on Wednesday, September 16, the resolutions sent forward by the Committee of Recommendations, and printed in last week's NATURE, were adopted. In addition, the two following resolutions were carried:—

(1) That the systematic investigation of the upper currents of the atmosphere by means of kites or

1 "A New Method of Turpentine Orcharding," by Dr. C. H. Hertz. U.S. Department of Agriculture, *Bull.* xl., 1903.

balloons is of great importance in meteorology, and that the Council should take such steps as they might think fit to urge upon the Treasury the importance of providing the Meteorological Council with the funds necessary for the purpose. (2) That the Sectional Committees be continued in existence until the appointment of the Sectional Committees for the succeeding year, on being summoned by the president of the committee or by the Council, and that they be authorised to bring to the notice of the Council in the interval between the annual meetings any matter which might be desired in the interest of the several sections.

At the concluding meeting, held on the same day, resolutions were proposed and unanimously carried conveying thanks to the Mayor and Corporation, Local Committee, and other bodies who had helped to make the meeting a success by their personal services and generous hospitality. Appreciation of the handsome way in which the visitors were treated was also expressed at a dinner which the Mayor of Southport, Mr. T. T. L. Scarisbrick, gave on Wednesday evening, when a distinguished company was entertained by him at Greaves Hall, Banks, to meet Sir Norman Lockyer and Prof. E. Mascart, president of the International Meteorological Committee.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY CAPTAIN ETTRICK W. CREAK, C.B., R.N., F.R.S., PRESIDENT OF THE SECTION.

OF the six distinguished naval officers who have previously presided over this Section, four were Arctic explorers; and therefore, possessing personal experience in Arctic regions, they naturally gave prominence to the deeply interesting subject of the past and future of Arctic discovery in their addresses, whilst not forgetting other matters relating to the geography of the sea. The remaining officers, from their immediate connection with all that relates to the physical condition of the ocean, in its widest sense, coupled with the great importance of giving the fruits of their knowledge to the world, took that subject as their principal theme.

Valuable as are contributions to our knowledge of the physics of the ocean to the world in general, and especially to the mariner and water-borne landsman, I propose to take a different course, and bring to your notice the subject of Terrestrial Magnetism in its relation to Geography. In doing so, I shall endeavour to show that much may be done by the traveller on land and the seaman at sea in helping to fathom the mysteries connected with the behaviour of the freely suspended magnetic needle, as it is carried about over that great magnet, the Earth, by observations in different regions, and even in limited areas.

I would, however, pause a moment to call attention to the presence of several distinguished meteorologists at this meeting, who will surely attract many to the consideration of matters connected with the important science of meteorology, which already occupies considerable attention from travellers. I feel sure, therefore, that geographers will be glad to accord a hearty welcome to the members of the International Meteorological Congress now assembled in this town, and especially to the foreign visitors who honour us by their presence.

Someone may ask, What has Terrestrial Magnetism to do with Geography? I reply, excellent lectures on that subject of growing importance have been given under the direct auspices of the Royal Geographical Society; one in 1878 by the late Captain Sir Frederick Evans, and another in 1897 by Sir Arthur Rücker. And I would here quote the opinion of Dr. Mill when defining geography, in my support: "Geography is the science which deals with the forms of the Earth's crust, and with the influence which these forms exercise on the distribution of other phenomena."

We know now that the normal distribution of the Earth's magnetism for any epoch is in many localities seriously affected accordingly as the nature of the country surveyed be mountainous, or generally a plain, in the form of islands (or mountains standing out of the sea), and from land under the sea. There is also reason to suspect that the magnetism of that portion of the earth covered by the oceans differs in intensity from that of the dry land we inhabit. A connection between the disturbances of the earth's crust in earthquakes and disturbances of the magnetic needle also seems to exist, although the evidence on this point is not conclusive.

Magnetic Surveys.

Previously to the year 1880 there were two periods of exceptional activity on the part of contributors to our knowledge of the earth's magnetism, during which the scientific sailor in his ship on the trackless ocean combined with his brethren on land in making a magnetic survey of the globe.

The first period was that of 1843–49, during which not only were fixed observatories established at Toronto, St. Helena, Capetown, and Hobart for hourly observations of the movements of the magnetic needle, but, to use Sabine's words, "that great national undertaking, the Magnetic Survey of the South Polar Regions of the Globe," the forerunner of our present Antarctic Expedition, was accomplished by Ross and his companions almost entirely at sea.

This Antarctic survey was carried out during the years 1840–45, and the results given to the world as soon as possible by Sabine. The results afterwards formed a valuable contribution when constructing his maps of equal lines of Magnetic Declination, Inclination, and Intensity for the whole world, a great work for the completion of which Sabine employed every available observation made up to the year 1870, whether on land or at sea.

Readers of these contributions cannot fail to be struck with the great number of observations made by such travellers as Hansteen and Due, Erman and Wrangel, extending from Western Europe to far into Siberia.

The second period was that of 1870–80, during which not only was there much activity amongst observers on land, but that expedition so fruitful to science, the voyage of H.M.S. *Challenger*, took place. During the years 1872–76 we find the sailor in the *Challenger* doing most valuable work in carrying out a magnetic survey of certain portions of the great oceans, valuable not only for needful uses in making charts for the seaman, but also as a contribution to magnetic science.

Prior to this expedition very little was known from observation of the distribution of Terrestrial Magnetism in the central regions of the North and South Pacific Oceans, and Sabine's charts are consequently defective there.

Combining the *Challenger* magnetical results with those of all available observations made by others of H.M. ships, and by colonial and foreign Governments, I was enabled to compile the charts of the magnetic elements for the epoch 1880, which were published in the report of the scientific results of H.M.S. *Challenger*. I will venture to say that these charts give a fairly accurate representation of the normal distribution of the earth's magnetism between parallels of 70° N. and 40° S. Beyond these limits, either northward or southward, there is a degree of uncertainty about the value of the lines of equal value, especially in the Southern regions, an uncertainty which we have reason to hope will be dissipated when we know the full results obtained by Captain Scott and the gallant band he commands, for as yet we have to be content with some eddies of the full tide of his success.

Until the *Discovery* was built, the *Challenger* was the last vessel specially selected with the view of obtaining magnetic observations at sea, so that for several years past results obtained on land have been our mainstay. Thus, elaborate magnetic surveys with fruitful results have been carried out in recent years in the British Isles by Rücker and Thorpe. France, Germany, Holland, and some smaller districts in Europe have also been carefully surveyed, and British India partially so, by Messrs. Schlagintweit in 1857–58. The latter country is being again magnetically surveyed under the auspices of the Indian Government.

On the American continent the Coast and Geodetic survey of the vast territories comprised in the United States, which has been so many years in progress, has been accompanied by an extended magnetic survey during the last fifty-two years, which is now under the able direction of Dr. L. A. Bauer. Resulting from this some excellent charts of the magnetic declination in the United States have been pub-

lished from time to time; and the last, for the epoch 1902, is based upon 8000 observations.

There are other contributions to terrestrial magnetism for positions on various coasts from the surveying service of the Royal Navy, and our ships of war are constantly assisting with their quota to the magnetic declination, or variation, as sailors prefer to call it; and wisely so, I trow, for have they not the declination of the sun and other heavenly bodies constantly in use in the computation of their ship's position?

This work of the Royal Navy and the Indian Marine is one of great importance, both in the interests of practical navigation and of science; for besides the equipment of instruments for absolute determinations of the declination, dip, and horizontal force supplied to certain of our surveying ships, every seagoing vessel in the service carries a landing compass, specially tested, by means of which the declination can be observed with considerable accuracy on land.

Although observers of many other objects may still speak of their "heritage the sea" as a mine of wealth waiting for them to explore, unfortunately for magnetic observations we can no longer say "the hollow oak our palace is," for wood has been everywhere replaced by iron or steel in our ships, to the destruction of accurate observations of dip and force on board of them. Experience, however, has shown that very useful results, as regards the declination, can be obtained every time a ship is "swung," either for that purpose alone, or in the ordinary course of ascertaining the errors of the compass due to the iron or steel of the ship.

As an example of this method, the cruise of the training squadron to Spitsbergen and Norway in 1895 may be cited, when several most useful observations were made at sea in regions but seldom visited. Again, only this year a squadron of our ships, cruising together near Madagascar, separated to a distance of a mile apart and "swung" to ascertain the declination.

I would here note that all the magnetic observations made by the officers of H.M. ships during the years 1890–1900 have been published in a convenient form by the Hydrographic Department of the Admiralty.

The fact remains, however, that a great portion of the world, other than the coasts, continues unknown to the searching action of the magnetic needle, whilst the two-thirds of the globe covered by water is still worse off. Amongst other regions I would specify Africa, which, apart from the coasts, Cape Colony, and the Nile valley to lat. 5½° N., is absolutely a new field for the observer.

Moreover, the elaborate surveys I have mentioned show how much the results depend upon the nature of the locality. I am therefore convinced that travellers on land, provided with a proper equipment of instruments for conducting a land survey of the strange countries which they may visit, and mapping the same correctly, can, with a small addition to the weight they have to carry, make a valuable contribution to our knowledge of terrestrial magnetism, commencing with observations at their principal stations and filling in the intermediate space with as many others as circumstances will permit.

The Antarctic Expedition.

Of the magnetic work of our Antarctic expedition we know that since the *Discovery* entered the pack—and, so far as terrestrial magnetism is concerned, upon the most important part of that work—every opportunity has been seized for making observations.

Lyttelton, New Zealand (where there is now a regular fixed magnetic observatory), was made the primary southern base-station of the expedition; the winter quarters of the *Discovery*, the secondary southern base-station. Before settling down in winter quarters, magnetic observations were made on board the ship during the cruise to and from the most easterly position attained off King Edward VII. Land in lat. 76° S., long. 152½° W., and she was successfully swung off Cape Crozier to ascertain the disturbing effects of the iron upon the compasses and dip and force instruments mounted in the ship's observatory.

As a ship fitted to meet the most stormy seas and to buffet with the ice, the *Discovery* has been a great success. Let me add another tribute to her value. From Spithead until she reached New Zealand but small corrections were required for reducing the observations made on board. The experience of Ross's Antarctic expedition had, however, taught the lesson that two wood-built ships, the *Erebus* and *Terror*, with but some 3° to 4° of deviation of the compass at Simon's Bay, South Africa, found as much as 56° of deviation at their position farthest south, an amount almost prohibitory of good results being obtained on board.

How fared the *Discovery*? I have been told by Lieutenant Shackleton—for the cause of whose return to England we must all feel great sympathy—that a maximum of only 11° of deviation was observed at her most southerly position. From this we may look forward hopefully to magnetic results of a value hitherto unattained in those regions.

At winter quarters, besides the monthly absolute observations of the magnetic elements, the Eschenhagen variometers or self-registering instruments for continuously recording the changes in the declination, horizontal force, and vertical force were established, and in good working order at the time appointed for commencing the year's observations.

I may here remind you that some time previously to the departure of the British and German Antarctic expeditions, a scheme of co-operation had been established between them, according to which observations of exactly the same nature, with the same form of variometers, were to be carried out at their respective winter quarters during a whole year, commencing March 1, 1902. Besides the continuous observations with the variometers, regular term-days and term-hours were agreed upon for obtaining special observations with them at the same moment of Greenwich mean time. Both expeditions have successfully completed this part of their intended work.

To co-operate in like manner with these far southern stations, the Argentine Government sent a special party of observers to Staten Island, near Cape Horn, and the Germans another to Kerguelen Land, whilst New Zealand entered heartily into the work. In addition, similar observations were arranged to be made in certain British and colonial observatories, which include Kew, Falmouth, Bombay, Mauritius, and Melbourne; also in German and other foreign observatories.

We have all read thrilling accounts of the journeys of the several travelling parties which set out from the *Discovery*, and of the imminent dangers to life they encountered and how they happily escaped them except one brave fellow named Vince, who disappeared over one of those mighty ice-cliffs, upon which all Antarctic voyagers descant, into the sea. In spite of all this there is a record of magnetic observations taken on these journeys of which only an outline has yet been given. Anticipations of the value of these observations are somewhat clouded when we read in one report that hills "more inland were composed of granite rock, split and broken, as well as weatherworn, into extraordinary shapes. The lower or more outer hills consisted of quartz, &c., with basaltic dykes cutting through them." Consequently, we have to fear the effects of local magnetic disturbances of the needle in the land observations, whilst buoyed up with the hope of obtaining normal results on board the ship.

Judging from some land observations which have been received, it appears that considerable changes have taken place in the values of the magnetic elements in the regions we are considering, but when making comparisons we have to remember the sixty years which have elapsed since Ross's time, and that he had nothing like the advantage of steam for his ships, or of instruments of precision like our present ship *Discovery*. His ships also were, as we have already remarked, much worse magnetically, causing far more serious disturbance of the instruments. Hence the changes we note may not be entirely due to changes in the earth's magnetism.

The observations made by the officers of the *Southern Cross* at Cape Adare in 1899–1900 also contribute to this question of magnetic change.

The Magnetic Poles of the Earth.

I will now refer to those two areas on the globe where the dipping needle stands vertically, known as the magnetic poles. The determination of the exact position of these areas is of great importance to magnetic science, and I will just glance at what is being done to solve the problem.

Let us consider the North Pole first, the approximate position of which we know best from observation. If one were asked to say *exactly* where that pole has been in observ-

ation times, whether it has moved, or where it now is, the answer must be "I do not know." It is true that Ross in 1831, by a single observation, considered he had fixed its position, and I believe hoisted the British flag over the spot, taking possession thereof; but he may or may not have set up his dip circle over a position affected by serious magnetic disturbance, and therefore we must still be doubtful of his complete success from a magnetic point of view. Although eminent mathematicians have calculated its position, and Neumayer in 1885 gave a place to it on his charts of that year, we have still to wait for observation to settle the question, for one epoch at least.

Happily, I am able to repeat the good news that the Norwegian, Captain Roald Amundsen, sailed in June last with the express object of making a magnetic survey of Ross's position and of the surrounding regions, in order to fix the position of the north magnetic pole. Furnished with suitable instruments of the latest pattern, he proposes to continue his investigations until 1905, when we may look for his return and the fulfilment of our hopes.

So far as we can now see, the south magnetic pole cannot be approached very nearly by the traveller, and we can only lay siege to it by observing at stations some distance off but encircling it. We have our own expedition on one side of it, and now with the return of the *Gauss* to South Africa in June last, we have learnt that that vessel wintered in lat. 66° 2′ S., long. 89° 48′ E., a position on the opposite side of the supposed site of the magnetic pole to that of the *Discovery*. We may now pause to record our warm congratulations to Dr. von Drygalski and his companions on their safe return, accompanied by the welcome report that their expedition has proved successful.

In addition to the British and German expeditions, there are the Swedish expedition and the Scottish expedition. Therefore, with so many nationalities working in widely different localities surrounding it, we have every reason to expect that the position of the south magnetic pole will be determined.

The Secular Change.

When in the year 1600 Gilbert announced to the world that the earth is a great magnet, he believed it to be a stable magnet; and it was left to Gellibrand, some thirty-four years later, by his discovery of the annual change of the magnetic declination near London, to show that this could hardly be the case. Ever since then the remarkable and unceasing changes in the magnetism of the earth have been the subject of constant observation by magneticians and of investigation by some of the ablest philosophers in Europe and America. Year after year new data are amassed as to the changes going on in the distribution of the magnetism of the earth, but as yet we have been favoured by hypotheses only as to the causes of the wondrous changes which the magnetic needle records.

These hypotheses were at one time chiefly based upon a consideration of the secular change in the declination, but it is now certain that we must take into account the whole of the phenomena connected with the movements of the needle, if we are to arrive at any satisfactory result. Besides, it will not suffice to take our data solely from existing fixed observatories, however relatively well placed and equipped, and valuable as they certainly are, for it now appears that the secular change is partly dependent upon locality, and that even at places not many miles apart differences in results unaccounted for by distance have been obtained.

The tendency of observation is increasingly to show that the secular change of the magnetic elements is not a world-wide progress of the magnetic needle moving regularly in certain directions, as if solely caused by the regular rotation during a long series of years of the magnetic poles round the geographical poles, for if you examine Map No. 1, showing the results of observations during the years 1840–80 as regards secular change, you will observe that there are local causes at work in certain regions, whilst in others there is rest, which must largely modify the effect of any polar rotation.

Allow me to explain further. The plain lines on Map No. 1 indicate approximate regions of no secular change in the declination, and the small arrows the general direction (not the amount) in which the north-seeking end of the horizontal needle was moving during those forty years. The foci of greatest change in the declination, with the approximate amount of annual change in the northern hemisphere, are shown in the German Ocean and N.W. Alaska, in the southern hemisphere off the coast of Brazil, and in the South Pacific between New Zealand and Cape Horn. The two foci of greatest annual change in the dip are shown, one in the Gulf of Guinea where the north-seeking end of the needle was being repelled strongly upwards, the other on the west side of Tierra del Fuego, where the north-seeking end of the needle was being attracted strongly downwards.

It is remarkable that the lines of no change in the declination pass through the foci of greatest change in the dip. If the needle be repelled upwards, as at the Gulf of Guinea focus, it will be found to be moving to the eastward on the east side of the whole line of no change in the declination from the Cape of Good Hope to Labrador; to the westward on the west side. If the needle be attracted downwards, as at the Tierra del Fuego focus, it will be found moving to the westward on the east side of the whole line of no declination from that focus to near Vancouver Island; to the eastward on the west side.

A similar result may be seen in the line passing through a minor focus of the dip near Hong Kong.

Judging from analogy there should be another focus of change in the dip in lat. 70° N., long. 115° E., or about the position assigned to the Siberian focus of greatest force.

On Map No. 2 are shown lines of equal value of the declination—the red lines for the year 1880, the black lines for the year 1895. From these, when shown on a large scale, we may deduce the mean annual change which has taken place in the declination during the fifteen years elapsed.

In this map we are reminded of the different results we obtain in different localities, for if a line be drawn from Wellington in New Zealand past Cape York in Australia to Hong Kong, little or no change will be found in the neighbouring region since 1840. Again, the line of no change in the declination shown on Map No. 1 to be following much the same direction as the great mountain ranges on the west side of the American continent has hardly moved for many years according to the observations available.

On the other hand, let us now turn to an example of the remarkable changes which may take place in the declination unexpectedly and locally. The island of Zanzibar and the east coast of Africa were constantly being visited by our surveying-ships and ships of war up to the year 1880, observations of the declination being made every year at Zanzibar during the epoch 1870–80. The results showed that from Capetown nearly to Cape Guardafui the annual change of that element hardly exceeded 1′.

During the succeeding years of 1890–91 observations were made by the Germans at Dar-es-Salaam and some other places on the neighbouring coasts, with the result that the declination was found to be changing at first 3′ annually, and since that period it had reached 10′ to 12′ at Dar-es-Salaam. Subsequent observations at the latter place in 1896–98 confirmed the fact of the great change, and in addition our surveying-ship on the station, specially ordered to "swing" at different places in deep water off the coast, generally confirmed the results. It is remarkable that whilst such great changes should have taken place between Capetown and Cape Guardafui, Aden and the region about the straits of Bab-el-Mandeb seem to be comparatively unaffected.

Local Magnetic Disturbance.

In Map No. 2 normal lines of equal value of the declination are recorded, and so far as the greater part of the globe covered by water is concerned, we may accept them as undisturbed values, for we have yet to learn that there are any local magnetic disturbances of the needle in depths beyond 100 fathoms.

When, however, we come to the land, there is an increasing difficulty in finding districts of only a few miles in extent where the observed values of the magnetic elements at different stations therein do not differ more widely than they should if we considered only their relative position on the earth as a magnet. Take Rücker and Thorpe's maps of the British Isles and those of the United States, for example, where the lines of equal value are drawn in accordance with the observations, with the result that they form extraordinary loops and curves differing largely from the normal curves of calculation.

From among numerous examples of disturbance of the declination on land, two may be quoted. In the Rapakivi district, near Wiborg, a Russian surveying officer in the year 1890 observed a disturbance of 180°, or, in other words, the north point of his compass pointed due south. At Invercargill, in New Zealand, within a circle of 30 feet radius, a difference of 56° was found. Even on board ships in the same harbour different results are sometimes observed, as our training squadron found at Reikiavik in Iceland, and notably in our ships at Bermuda.

It is hardly necessary to add that the dip and force are often largely subject to like disturbance, but I do so in order to warn travellers and surveyors that observations in one position often convey but a partial truth; they should be supplemented by as many more as possible in the neighbourhood or district. Erroneous values of the secular change have also been published from the various observers not having occupied exactly the same spot, and even varied heights of the instrument from the ground may make a serious difference, as at Rapakivi before mentioned, and at Madeira, where the officers of the *Challenger* expedition found the dip at a foot above the ground to be 48° 46′ N.; at 3½ feet above the ground 56° 18′ N. at the same spot.

All mountainous districts are specially open to suspicion of magnetic disturbance, and we know from comparison with normal observations at sea that those mountains standing out of the deep sea, which we call islands, are considerably so affected.

Magnetic Shoals.

The idea that the compasses of ships could be affected by the attraction of the neighbouring dry land, causing those ships to be unsuspectingly diverted from their correct course, was long a favourite theory of those who discussed the causes of shipwreck, but it was "a fond thing vainly invented." I can hardly say this idea is yet exploded, but from what has already been said about local magnetic disturbance on land, it is not a matter of surprise that similar sources of disturbance should exist in the land *under* the sea, for it has been found that in certain localities, in depths of water sufficient to float the largest ironclad, considerable disturbances are caused in the compasses of ships.

An area of remarkable disturbance having been reported as existing off Cossack, N.W. Australia, H.M.S. *Penguin*, a surveying-ship provided with the necessary magnetic instruments, was sent by the Admiralty in 1891 to make a complete magnetic survey of the locality, with a view to ascertain the facts and place them on a scientific basis. An area of disturbance 3·5 miles long by 2 miles broad, with not less than 8 fathoms of water over it, was found lying in a N.E. by E. and S.W. by W. direction. At one position the disturbing force was sufficient to deflect the *Penguin's* compass 56°; in another—the focus of principal disturbance—the dip on board was increased by 29°, and this at a distance of more than 2 miles from the nearest visible land, upon which only a small disturbance of the dip was found.

This remarkable area of disturbance was then called a "Magnetic Shoal," a term which at first sight hardly appears to be applicable. We have, however, become familiar with the terms "ridge line, valley line, peak, and col," as applied to areas of magnetic disturbance on land; therefore I think we may conveniently designate areas of magnetic disturbance in land under the sea "Magnetic Shoals."

This year H.M. surveying-ship *Research* has examined and placed a magnetic shoal in East Loch Roag (Island of Lewis), but as all our surveying-ships are practically iron ships, it was impossible from observations on board to obtain the exact values of the disturbing forces prevailing in this shoal. The reason for this is that, although we may accurately measure the disturbing forces of the iron of the ship in deep water, directly she is placed over the shoal induction takes place, and we can no longer determine to what extent the observed disturbances are due to the ship's newly developed magnetism, or to what extent the shoal alone produces them.

We can, nevertheless, even in an iron ship, accurately *place* and show the dimensions of a magnetic shoal and the *direction* in which a ship's compass will be deflected in any part of it by compass observations only. Is it not, therefore, the duty of any ship meeting with such shoals to stop and fix their position?

The general law governing the distribution of magnetism on these magnetic shoals is that in the northern hemisphere the north point of the compass is drawn *towards* the focus of greatest dip; in the southern hemisphere it is *repelled*. The results at East Loch Roag proved an exception, the north point of the compass being *repelled*.

Terrestrial Magnetism and Geology.

I have already referred to the question of local magnetic disturbance as one of great importance in magnetic surveys. The causes of these disturbances were at one time a matter of opinion, but the evidence of the elaborate magnetic surveys I have alluded to, when compared with the geological maps of the same countries, points clearly to magnetic rocks as their chief origin.

Magnetic rocks may be present, but from their peculiar position fail to disturb the needle; but, on the other hand, as Rücker writes in his summary of the results of the great magnetic survey of the British Isles conducted by Thorpe and himself, "the magnet would be capable of detecting large masses of magnetic rock at a depth of several miles," a distance not yet attained by the science of the geologist.

Again, Dr. Rijckevorsel, in his survey of Holland for the epoch 1891, was convinced that "in some cases, in many perhaps, there must be a direct relation between geology and terrestrial magnetism, and that many of the magnetic features must be in some way determined by the geological structure of the under-ground."

During the years 1897–99 a magnetic survey was made of the Kaiser-stuhl, a mountainous district in the neighbourhood of Freiburg, in Baden, by Dr. G. Meyer. Exact topographical and geological surveys had been previously made, and the object of the magnetic survey was to show how far the magnetic disturbances of the needle were connected with geological conformations. Here, again, it was found that the magnetic and geological features of the district showed considerable agreement, basaltic rocks being the origin of the disturbance. This was not all, for in the level country adjacent to the Rhine and near Breisach unsuspected masses of basalt were found by the agency of the magnetic needle.

More recently we find our naval officers in H.M.S. *Penguin*, with a complete outfit of magnetic instruments, making a magnetic survey of Funafuti atoll and assisting the geologist by pointing out, by means of the observed disturbance of the needle, the probable positions in the lagoon in which rock would be most accessible to their boring apparatus.

Leaving the geologist and the magnetician to work in harmony for their common weal, let us turn to some other aspects of the good work already accomplished and to be accomplished by magnetic observers.

Magnetic Charts.

Of the valuable work of the several fixed magnetic observatories of the world, I may remark that they are constantly recording the never-ceasing movements of the needle, the key to many mysteries to science existing in the world and external to it, but of which we have not yet learnt the use. Unfortunately many of these once fixed observatories have become travellers to positions where the earth can carry on its work on the needle undisturbed by electric trams and railways which have sprung up near them, and it is to be hoped they will find rest there for many years to come.

Of the forty-two observatories which publish the values of the magnetic elements obtained there, thirty-two are situated northward of the parallel of 30° N., and only four in south latitude; and it is a grief to magneticians that so important a position as Capetown or its neighbourhood does not make an additional fixed magnetic observatory of the first order.

Thus, so far as our present question of magnetic charts and their compilation is concerned, the observatories do not contribute largely, but we should be very grateful to them for the accurate observations of the secular change they provide which are so difficult to obtain elsewhere.

Of the value of magnetic charts for different epochs I have much to say, as they are required for purely scientific inquiry as well as for practical uses. It is only by their means that we can really compare the enormous changes which take place in the magnetism of the globe as a whole; they are useful to the miner, but considerably more so to the seaman.

Had it not been for the charts compiled from the results of the untiring labours of travellers by land and observers at sea in the field of terrestrial magnetism during the last century, not only would science have been miserably poorer, but it is not too much to say that the modern iron or steel steamship traversing the ocean on the darkest night at great speed would have been almost an impossibility, whereas with their aid the modern navigators can drive their ships at a speed of 26·5 statute miles an hour with comparative confidence, even when neither sun, moon, nor stars are appearing.

Of the large number of travellers by sea, including those who embark with the purpose of increasing our geographical knowledge of distant lands and busying themselves with most useful inquiries into the geology, botany, zoology, and meteorology of the regions they visit, few realise that when they set foot on board ship (for all ships are now constructed of iron or steel) they are living inside a magnet. Truly a magnet, having become one by the inductive action of that great parent magnet—the Earth.

How fares the compass on board those magnets, the ships, that instrument so indispensable to navigation, which Victor Hugo has forcibly called "the soul of the ship," and of which it has been written,

> "A rusted nail, placed near the faithful compass,
> Will sway it from the truth, and wreck an argosy"?

And if so small a thing as an iron nail be a danger, what are we to say to the iron ship? Let us for a moment consider this important matter.

If the nature of the whole of the iron or steel used in construction of ships were such as to become permanently magnetic, their navigation would be much simplified, as our knowledge of terrestrial magnetism would enable us to provide correctors for any disturbing effects of such iron on the compass, which would then point correctly. But ships, taken as a whole, are generally more or less unstable magnets, and constantly subject to change, not only on change of geographical position, but also of direction of the ship's head with regard to the magnetic meridian. Thus a ship steering on an easterly course may be temporarily magnetised to a certain extent, but on reversing the ship's course to west she would after a time become temporarily magnetised to the same amount, but in the opposite direction, the north point of the compass being attracted in each case to that side of the ship which is southernmost.

Shortly, we may define the action of the earth's magnetism on the iron of a ship as follows: The earth being surrounded by a magnetic field of force differing greatly in intensity and direction in the regions from the North Pole to the Equator and the Equator to the South Pole, the ship's magnetic condition is largely dependent upon the direction of her head whilst building and the part of that field she occupied at the time; partly upon her position in the magnetic field she traverses at any given time during a voyage.

For the reasons I have given, magnetic charts are a necessity for practical purposes and in the following order of value. That of the magnetic declination or variation which is constantly in use, especially in such parts of the world as the St. Lawrence and the approaches to the English Channel, where the declination changes very rapidly as the ship proceeds on her course. Next, that of the dip and force, which are not only immediately useful when correcting the ship's compass, but are required in the analysis of a ship's magnetism both as regards present knowledge and future improvements in placing compasses on board.

If astronomers have for a very long time been able to publish for several years in advance exact data concerning the heavenly bodies, is it too much to hope that magneticians will before long also be able to publish correct magnetic charts to cover several years in advance of any present epoch? If this is to be done within reasonable time there must be a long pull, a strong pull, and a pull all together of magnetic observers in all lands, and accumulated data must also be discussed.

On Magnetic Instruments for Travellers.

Travellers in unsurveyed countries, if properly instructed and equipped, can do good service to science by observing the three magnetic elements of declination, inclination or dip, and force at as many stations as circumstances will permit; hence the following remarks.

For the purpose of making the most exact magnetic survey the best equipment of instruments consists of the well-known unifilar magnetometer, with fittings for observing the declination, and a Barrow's dip circle. To some travellers these instruments might be found too bulky, and in some regions too delicate as well as heavy to carry.

Of suitable instruments made abroad, those used by M. Moureaux in his survey of France may be mentioned, as they are of similar type, but much smaller and lighter than the instruments above mentioned.

Another form of instrument, called an L.C. instrument, for observing both the inclination and total force, is shown in the instrument before you. Originally designed for observations on board ships at sea where the ordinary magnetic instruments are unmanageable, it has also been found to give satisfactory results in a land survey, where greater accuracy is expected than at sea. Thus, during a series of observations extending from the north side of Lake Superior to the southern part of Texas last year, comparisons were made between the results obtained with an L.C. instrument and those of the regular unifilar magnetometer and dip circle, when the agreement was found satisfactory.

I am therefore of the opinion that a traveller furnished with a theodolite for land-surveying purposes, but fitted with a reversible magnetic needle, can at any time he observes a true bearing obtain a trustworthy value of the declination. Dismounting the theodolite from his tripod, the latter will serve for mounting an L.C. instrument with which to observe the inclination and force. Thus, by adding to his ordinary equipment an instrument weighing in its box about 21 lb., he can obtain valuable contributions to terrestrial magnetism, and at the same time give useful assistance to geological investigations.

Concluding Remarks.

Although a great subject like terrestrial magnetism, even to exhibit our present knowledge of the science, cannot be brought within the compass of an address—for it requires a treatise of many pages—I have brought some of the broad features of it before the Section in order to show its connection with Geography.

I also entertain the hope that geographers will become more interested in a subject so important to pure science and in its practical applications, and that it will become an additional subject to the instruction which travellers can now obtain under the auspices of the Royal Geographical Society in geology, botany, zoology, meteorology, and surveying.

There is a wide field open to observers, and where results often depend so much upon locality we require to explore more and more with the magnetic needle. To look over the great oceans and think how little is being done for terrestrial magnetism is a great matter for regret. Yet even there we may begin to be hopeful, for the United States Coast and Geodetic Survey authorities are making arrangements to fit out its vessels with the necessary instruments for determining the magnetic elements at sea.

We wish them all success; but I must again remind you that although we cannot compel observers to start, there is room for them and to spare.

I would fain make some remarks on the prevailing ignorance of sound geography in many quarters, and on the defective methods of teaching the science; but I feel that the subject is placed in very able hands, and will be fully discussed elsewhere during the present meeting.

SECTION G.

ENGINEERING.

OPENING ADDRESS BY MR. CHARLES HAWKSLEY, PAST PRESIDENT INST.C.E., PRESIDENT OF THE SECTION.

SINCE the last meeting of the British Association there has passed from our midst, to the deep regret of all who had the privilege of knowing him, one who, though full of years, actively followed his profession as a Civil Engineer until within a few days of his death. I refer to Mr. Edward Woods, who presided over Section G of the British Association at Plymouth in 1877. Mr. Woods commenced his professional career on the Liverpool and Manchester Railway soon after it was opened for traffic. In 1875 Mr. Woods was invited by the Royal Commission on Railway Accidents to undertake, in conjunction with Colonel Inglis,

R.E., an exhaustive series of trials of the different kinds of railway brakes then in use in England, the results of which were recorded in an elaborate and valuable report. These trials were referred to by Mr. Woods in his address as President of Section G. Mr. Woods was President of the Institution of Civil Engineers in 1886–1887, and he died on June 14, 1903, at the ripe age of eighty-nine.

TECHNICAL EDUCATION.

The subject of the technical education of engineers was treated very fully in the interesting address delivered by Prof. Perry, as President of Section G at the meeting of the British Association in Belfast last year. This question also received thorough consideration at the meeting of the Engineering Conference held in London in June last, as well as at recent meetings of the Institution of Mechanical Engineers and of the Institute of Naval Architects. The systems in vogue in the United States of America and on the Continent of Europe were on those occasions brought forward in carefully prepared papers and fully discussed. The main points at issue are: (1) whether actual handicraft should be taught in the Technological School or College along with the principles underlying the Engineers' art; (2) whether the year should be divided into periods in one or more of which the science of engineering should be taught, and in another or others of which craft skill should be acquired at works; (3) whether the principles should be first acquired, during a longer or shorter term, leaving experience in applying those principles to be gained at the termination of the course. As regards the first of these suggestions it appears to be in opposition to the judgment of the most experienced teachers. In respect to the second, the Admiralty have carried it out for the last forty years, and with satisfaction to the Service; it is also common in Glasgow, and Mr. Yarrow has included this system in the apprenticeship rules he has recently laid down, whilst it is to be tried experimentally in the Engineering Course at King's College, London. At the Engineering Conference it was determined that the subject was of such importance that its further consideration should be left to a Committee, to be subsequently appointed.

Since the British Association last met in Lancashire (in 1896) there have been important events and changes in the chief technical institutions of the county. First, there were last year the Jubilee celebrations of Owens College, Manchester, when it received congratulations on its half-century of work from universities and learned societies in all parts of the world. Here, as I need hardly remind you, the engineering laboratory is under the able direction of Prof. Osborne Reynolds, F.R.S., who presided over Section G of the British Association at their Meeting in Manchester in 1887. Then, also in Manchester, there is the recently completed and admirable Municipal School of Technology; but as a paper will be read on this subject, and members will have an opportunity of visiting the school and inspecting its engineering laboratory, I will content myself with wishing it every success in the manifold fields of industrial education in which it is engaged. Again, only this year Victoria University has lost a College, and Liverpool has gained a University. At University College, Liverpool, in the Session of 1884–5, a Professorship of Engineering was instituted as a provisional measure. The erection of engineering laboratories and the endowment of the Chair were afterwards provided for by gifts in commemoration of the Jubilee year of the reign of Her late Majesty, Queen Victoria. Prof. H. E. Hele-Shaw, F.R.S., was appointed to the Chair in the first instance, a position which he still continues to hold.

This year a Royal Charter has been granted establishing the University of Liverpool, and transferring to it the powers of University College, Liverpool. I think one cannot offer to the University of Liverpool a heartier wish than that it may be as successful in the future as University College, Liverpool, has been in the past, a wish in which I am sure you will all join.

There is yet one other college to which, though not in Lancashire, I should like to make a passing reference, the first to include engineering in its educational curriculum, viz. University College, London. It was originally founded in 1828 under the name of the "University of London," and has recently, together with King's College, become merged in the present University of London. The first engineering laboratory was established at University College in 1878, fifty years after the inauguration of the college, whilst a separate chair for electrical engineering was founded in 1885, and an electrical laboratory was added ten years ago. One cannot say farewell to it as it used to be without mentioning the name of Dr. A. B. W. Kennedy, F.R.S., who was President of this Section of the British Association in 1894 at Oxford, and who has done so much for engineering education.

Before leaving the subject of technical education, I venture to express the hope that in the training of engineering students increased attention will be paid to the combination of artistic merit with excellence of structural design, so that in respect to artistic treatment our engineering structures may not remain so far behind those of our Continental brethren as is unfortunately now frequently the case.

ENGINEERING STANDARDS.

A very important work has been going on quietly and unostentatiously in our midst for some time past, the results of which must affect the engineering profession at home and abroad. I refer to the work of the Engineering Standards Committee, which as many of my hearers know, was appointed in 1901 and is now composed of 178 members, among whom are many Government officials. I alluded to the earlier work of this Committee in my Presidential Address to the Institution of Civil Engineers in 1901, and that work has since been gradually but surely extended. The Committee has received not only the moral but the financial support of His Majesty's Government, and the results of its labours are being adopted by all the leading Government departments.

In addition to the main Committee there are no fewer than twenty-five separate committees and sub-committees engaged on work, covering a wide range of operations, many of the members sitting on more than one committee.

A few details of the work accomplished and in progress may be of interest. After careful deliberation the Committee published their first series of British standards sections, covering all rolled steel sections used in constructional work, shipbuilding and so forth. The Committee on Rails has just issued the standard sections and specification for British girder tramway rails, and it is now actively engaged in drawing up a series of standard sections of bull-headed and flat-bottomed rails for railway work.

Another committee of a thoroughly representative character is occupied in drawing up a standard specification and standard tests for cement, and a standard specification drawn up by so large a body of our leading engineers, contractors, and manufacturers must be of great interest to all those who are called on to specify tests for this material.

The Government of India control to a very considerable extent the working of railways in India, and they have referred to the Standards Committee the important question of drawing up a series of standard types of locomotives for use on the Indian railways. The Committee which investigated this difficult subject has just forwarded its report to the Secretary of State for India. Other committees are preparing standard specifications for locomotive copper fire-box plates and steel boiler plates, which it is hoped will be published at an early date.

The subject of screw-threads is one which has occupied a Committee of the British Association for some years past, and I am glad to learn that the Committee of this Association has been co-operating with the Standards Committee and discussing the question of screw-threads of both smaller and larger diameters, and also considering the cognate subject of limit gauges so essential to all accurate work in mechanical engineering.

Another Committee is dealing with standard flanges, and I understand it is shortly proposed to consider the standardisation of cast-iron pipes.

A very large and influential committee is engaged on the subject of the materials used in the construction of ships and their machinery, and most valuable information is being collected with a view to the preparation of a standard specification for steel and to the determination of forms for standard test-pieces to be used when testing plates, forgings, castings, and so forth.

There are about half a dozen committees engaged on various important electrical subjects, but as their work will

no doubt be referred to in another Section of this Association, I do not propose to make further reference to it here.

In my Presidential Address before the Institution of Civil Engineers in 1901, I raised a note of warning in regard to the stereotyping of design and the consequent cramping of originality. The constitution of the Standards Committee and the professional standing of its members afford a guarantee that its work will accord with the best practice of this country, since those engaged in drawing up the standards are not only in the forefront of engineering practice, but are alive to the necessity for extending the number of standards if and when needed to meet the requirements of the engineer.

National Physical Laboratory.

An outline scheme for a National Physical Laboratory was set forth in 1891, by Sir (then Dr.) Oliver Lodge, F.R.S., in his Address at Cardiff to Section A of the British Association. In his Presidential Address to this Association in 1895 at Ipswich, the late Sir Douglas Galton, F.R.S., emphasised the importance of such an Institution, a Committee of this Association reported in favour of it, and later, when after forwarding a petition to the late Lord Salisbury, a Treasury Committee with Lord Rayleigh, F.R.S., in the Chair was formed, Sir Douglas Galton gave evidence to the effect that if Great Britain was to retain its industrial supremacy, we must have accurate standards available to our research students and to our manufacturers.

In 1901, the National Physical Laboratory was inaugurated at Bushy House, near Teddington, and an annual grant of 4000*l.* towards its support was made by Government. It is divided into three departments, of which the one dealing with all branches of Civil, Mechanical, and Electrical Engineering is chiefly interesting to us in Section G In this department tests are now undertaken of the strength of materials of construction, of pressure and vacuum gauges, of indicators and indicator springs, and of length gauges and screw gauges, and photomicroscopic investigation is made of metals and alloys, and especially of steel rails.

But beside the ordinary work of testing, various investigations are in progress, such as measurement of wind pressure, elastic fatigue in nickel steel and other materials used by engineers, and the magnetic and mechanical properties of aluminium-iron and other alloys. For the British Association a set of platinum thermometers has been constructed and subjected to stringent tests, and an investigation has been undertaken for the Engineering Standards Committee into the changes in insulating strength of various dielectrics used in motors, transformers, &c., due to continued heating. In the language of Dr. Glazebrook, F.R.S., the Director, who it may be mentioned was previously Principal of University College, Liverpool, science is not yet regarded as a commercial factor in this country, but it is one of the aims of the National Physical Laboratory to bring about the alliance of science with commerce and industry. The expenditure of the National Physical Laboratory is met by an annual Treasury grant of 4000*l.*; 500*l.* a year from an endowment; fees for tests, now amounting to about 3500*l.* annually; and from donations and subscriptions.

The Director is anxious that the revenue derived from fees for testing should be largely augmented, and I would urge on engineers, contractors and manufacturers, as well as on private individuals, that they should avail themselves of the opportunity to have tests and experiments of interest to them, and which will be generally accepted as unimpeachable, conducted at this laboratory. I may add that an appeal has been made for further donations and annual contributions, as the funds now at the disposal of the Board of Management are insufficient to carry on the work of the laboratory on a sound financial basis, and I venture to hope that many of those who are interested in the practical applications of science will assist in supporting the work of this national institution.

Intercommunication.

General Progress.

At the commencement of the nineteenth century, Southport, which now has its parks, a promenade, and a pier more than three-quarters of a mile in length, its halls, free library, art gallery and science and art schools, and railway connection with all parts of the kingdom, was not even to be found on the maps, the first house having been erected in the year 1792. In 1851 the population of Southport and the adjoining place Birkdale was 5390, whereas at the census of 1901, Southport had a population of 48,083 and Birkdale 14,197, together 62,280. Here is evidence of great local enterprise, resulting in a development of which its people may be justly proud.

At the commencement of the nineteenth century the population of the United Kingdom was nearly 15¾ millions, at the beginning of the twentieth nearly 41½ millions. Then there was not a mile of railway in the United Kingdom: now there are about 22,000 miles. Here, too, is evidence not only of the prosperity which has prevailed throughout Great Britain during the century that has passed, but also of the enormously increased demands which have arisen during the same period on the means of locomotion.

It was towards the latter half of the eighteenth century that the formation of good roads was commenced in Lancashire and the adjoining counties by John Metcalf, the blind road-maker, and that Palmer in 1784 introduced mail coaches travelling at from six to seven miles an hour on the main roads. In 1801 the mail coach from London to Holyhead occupied nearly forty-six hours on the journey, and the mails reached Dublin on the third day after leaving London. Now the journey from London to Holyhead is performed in 5¾ hours, and Dublin is reached in 9¼ hours after leaving London.

In 1803, just one hundred years ago, Telford reported to the Government on the state of the roads, and as a result the great road to Liverpool from the Metropolis and the other great highways were constructed. It was enlightened wisdom that eighty years ago placed intercommunication in the forefront of the definition of engineering; it still maintains that position, and I purpose to say a few words on the present aspect of the question.

Road Traffic—Motors.

Speed in locomotion appears to be now the first consideration, whether as regards mails, passengers, or goods. I would refer in the first instance to locomotion on our main roads. Here three or four classes of machines appear to be ambitious to drive pedestrians, horsemen, and horse-drawn vehicles off the road.

The first practical steam carriage was used by Trevithick in the year 1802; and now, a hundred years later, it is found that for the traction of heavy loads on the main roads steam is still most suitable. The points of importance in connection with traction engines and their trailers are their speed, weight, and width; of course, there is no question that, as regards facilitating traffic, the large heavy waggon replacing many smaller horse-drawn ones will be found a boon. Mr. E. R. Calthrop, M.Inst.C.E., one of the founders of the Liverpool Self-propelled Traffic Association, is opposed to any weight restriction, but it must be remembered that the momentum of heavily laden waggons drawn by a powerful traction engine at the maximum speed of five miles an hour is very great, and causes uncomfortable vibration in the houses along the main thoroughfares of our towns; on the other hand, light traction engines are now being successfully used, drawing from four to five tons of market produce through the streets of London without causing undue vibration, and at a cost, I am informed, of about one-half that of horse traction.

But a far more burning question is that of the speed of motor cars along our public thoroughfares. The struggle to maintain a trophy at home, or to regain it from abroad, is one in which every inhabitant of this country sympathises. The great Gordon-Bennett Cup Race in July last redounded to the credit of the Automobile Club of Great Britain and Ireland, who made and carried out the arrangements and were at considerable pains to find a suitable course in a sparsely inhabited district; every measure which experience has shown to be needful having been taken to prevent accident. The race was decidedly international in character, French, Germans, Americans, and English contesting for the prize; and in heartily congratulating the German Automobile Club on their success, it may be noted that M.

Jenatzy covered a distance of 327½ miles in 6 hours 39 minutes, or at the rate of 49½ miles an hour, though he attained to a speed of 61 miles an hour between the points of control. Even this speed was exceeded at a trial in Phœnix Park, Dublin, when Baron de Forest attained to a rate of 86 miles an hour. But between racing speed and ordinary travelling speed there is necessarily a great difference, and our twenty miles maximum on country roads is in excess of that allowed in France, where it is now fixed, though I believe not enforced in the open country, at 18½ miles, and at 12½ miles where there is much traffic. The two classes of motors used for higher speeds are the petrol and the electric. The former are mainly internal-combustion engines; having to be light, they run at the comparatively high speed of 800 revolutions per minute. They are generally used in connection with bicycles, tricycles, or light carriages. They have also been used for light vans and coaches, and successful trials have been made with self-propelled lorries for military purposes, and by local authorities for watering and dust collecting. Their application to omnibuses has not proved economical, owing to the difficulty of providing pneumatic tyres for such heavy vehicles.

The electric motor depends on storage batteries; those in general use are of Planté's lead-couple type. Like the petrol motor, the electric motor is rather a luxury; most of the automobile carriages used in London are of this class; there is liability of injury to the batteries by over-discharging them. Colonel Crompton, in a paper recently read at the Engineering Conference, suggested the use of "standardised accumulators," to be supplied to the owners of electrical vehicles at depôts on production of a subscription ticket, and the Engineering Standards Committee has appointed a sub-committee to consider the question. Motor cars are now used by some of the railway companies as feeders to their lines, and also in competition with tramway lines.

The increasing use of motor cars renders more than ever necessary the regulation of traffic in crowded thoroughfares, a subject which will doubtless be dealt with in the paper on "The Problem of Modern Street Traffic," which Colonel Crompton is about to read before this Section of the British Association.

The use of motor-driven vehicles for road traffic is so intimately associated with improvements in prime movers that it will interest the members of this Section to be reminded of the opinion expressed more than twenty years ago by Sir Frederick Bramwell, F.R.S., Past President Inst.C.E., who presided over the Meeting of the British Association at Bath in 1888. In a paper read before this Section at the Jubilee Meeting of our Association at York in 1881, and afterwards printed *in extenso*, Sir Frederick Bramwell said: "However much the Mechanical Section of the British Association may to-day contemplate with regret even the mere distant prospect of the steam-engine becoming a thing of the past, I very much doubt whether those who meet here fifty years hence will then speak of that motor except in the character of a curiosity to be found in a museum." In a letter addressed to the President of this Association on July 2 last, Sir Frederick Bramwell directed attention to the largely increasing development of internal-combustion engines, and expressed a feeling of assurance that, although steam-engines might be at work in 1931, the output in that year would be small of steam as compared with internal-combustion engines.

To keep alive the interest of the Association in this subject, Sir Frederick Bramwell has kindly offered, and the Council has accepted, the sum of 50*l*. for investment in 2½ per cent. self-accumulative Consols, the resulting sum to be paid as an honorarium to a gentleman to be selected by the Council to prepare a paper having Sir Frederick's utterances in 1881 as a sort of text, and dealing with the whole question of the prime movers of 1931, and especially with the then relation between steam-engines and internal-combustion engines. That paper will doubtless prove to be a very valuable contribution to the proceedings of this Association, and one can only regret that many of those assembled here to-day cannot hope to be present when it is read, and to listen to an account of the nearest approach which has then been made towards the production of a perfect prime mover.

Electric Tramways and Light Railways.

I now pass to the application of electricity to tramways, and in doing so may quote from the careful expression of opinion given in this town from this Chair twenty years ago by the late Sir (then Mr.) James Brunlees, President of the Institution of Civil Engineers: "The working of railways by electricity has not advanced further than to justify merely a brief reference to it in this paper as among the possibilities, perhaps the probabilities, of the not distant future."

It was stated in a paper read by Mr. P. Dawson in April last before the Tramways and Light Railways Association, that the total route-length of electric tramways and light railways in the United Kingdom, either completed, under construction, or authorised, amounted at the end of last year to 3000 miles, the length of single track being 5000 miles, on which some 6000 cars were running.

It cannot, in my opinion, be regarded as being fair to the railway companies—which have to pay large sums of money for the land on which their lines have been constructed—to have to compete with tramways which are laid along the public roads without any payment being made for their use. The roads are disfigured by aërial conductors and the supporting posts by which the electric current is conveyed to the cars, except in those comparatively rare instances in which the conduit system is used; nor can it be denied that tramways greatly interfere with the use of the roads for ordinary traffic. The effect of electrolytic action on iron pipes laid beneath the roads is still undergoing investigation.

Railways.

Turning now to railways, it may be noted that on some of the principal lines in Great Britain the length of the runs without a stop is being increased in the case of fast trains, the speed of which is in some cases from forty-eight to fifty-nine miles an hour.

Railway companies are turning their attention to the introduction of electric traction wherever it can be beneficially used, as for instance on the Mersey Railway, the North-Eastern Railway between Newcastle-upon-Tyne and Tynemouth, and the Lancashire and Yorkshire Railway between Liverpool and Southport. With the object of facilitating the introduction and use of electrical power on railways, Parliament has passed an Act entitled the "Railways (Electrical Power) Act, 1903," which will come into operation on January 1 next.

The electrical service on the Mersey Railway has now been in regular and uninterrupted operation since the beginning of May in the present year. Trains are run at three-minute intervals, there being 750 trains in all between 5 a.m. and 12 midnight; and as it is the first example of a British steam railway converted to the use of electric traction, a short description of it cannot fail to be of interest.

The Mersey Railway was first opened for traffic on February 1, 1886, and was afterwards extended at both ends, the last extension to the Liverpool Central Station being opened for traffic in January, 1892. With steam locomotives, largely owing to the want of adequate ventilation, the railway was not a success. Electrification was decided upon, and in the latter part of 1901 the British Westinghouse Electric and Manufacturing Company, Limited, undertook the entire contract. The length of the railway is about 3¾ miles, and there are gradients in the tunnel below the river of 1 in 27 and 1 in 30.

The power station is at Birkenhead, and contains plant aggregating more than 6000 horse-power, comprising three engines of the Westinghouse-Corliss vertical cross-compound type.

The generators are all three alike, mounted on the engine shaft between the cylinders. They are standard Westinghouse multipolar machines, of the double-current type, of 1250 kilowatts capacity. Direct-current is collected from the armature at 650 volts, no alternating current being used at present.

Leads are carried below the floor from the machines to a switchboard, from which are controlled the main generators, the auxiliary lighting sets, battery, booster, and feeders. The battery consists of 320 chloride cells connected in parallel with the generators through a differential booster, and charge or discharge according as the line

load is light or heavy. They have a capacity of 1000 ampere-hours, and a momentary discharge capacity of 2000 amperes.

The auxiliary sets, two in number, are for lighting purposes, and yielding direct current at 650 volts, are available in case of need to supply current to the main traction circuits. 210 volt incandescent lamps are used for lighting, arranged in groups of three in series.

The feeders are carried from the switchboard down the ventilation shaft to feed the insulated electrical collector rails, which are placed in the space between the up and the down lines, and somewhat above the level of the rails, an insulated return collector rail being placed between each pair of rails. A train consists of two motor cars, one at each end, and from one to three trailers as required, depending on the amount of traffic. The motor cars each carry an equipment of four Westinghouse motors of 100 horse-power, making 400 horse-power per car, or 800 horse-power per train. These motors are all controlled in unison from the motorman's compartment at either end of the train by means of the Westinghouse multiple controlled system, which has worked from the start without a hitch.

In conclusion, it may be noted that every precaution has been taken against fire. The electrical equipment is all thoroughly fireproof, and the motorman's compartment is encased in asbestos slate, cutting it off completely from the remainder of the train.

Of tube railways with electric traction there are three now working in London, two between the City and the south side of the River Thames, using the ordinary two wire 500 volts continuous current system, and another (the Central London) extending from the City to Shepherd's Bush, using the composite system. This railway conveyed during the year 1902 no fewer than 45 million passengers. There are eight other tube railways now in course of construction in London. The recent terrible catastrophe in Paris must serve as a warning in the future equipment of such lines where currents at high tension are employed, and where short-circuiting may bring about disastrous results.

A paper will be read before this Section by Mr. F. B. Behr on the authorised Manchester and Liverpool Express Railway, which is intended to be constructed on the Mono-rail system, and to be worked electrically.

Canals.

Concurrently with the construction of roads in this country was the formation of canals, as a means of inland communication, mainly for the carriage of minerals and merchandise, though they also conveyed passengers by express boats. The only recent structure of this character in the United Kingdom is the famous Manchester Ship Canal, with which the name of Sir E. Leader Williams, M.Inst.C.E., is associated. This, however, is hardly a canal in the sense in which that word was employed by Brindley, "the father of inland canal navigation in England," as the largest amount by far, in the proportion of 10 to 1, is its seaborne as compared with its local traffic. It is interesting to notice that a very important wheat trade is being carried on with India, exported both from Bombay and Kurrachee. The seaborne traffic and the barge traffic for 1894 was 686,158 tons and 239,501 tons respectively, and has during eight years increased, until in 1902 it had reached 3,137,348 tons and 280,711 tons respectively. The most interesting recent development of the works is the new Dock now in course of construction, with its five sets of transit sheds, which are being built on the Ferro-Concrete system.

Ships.

The intercommunication of the nations of the world is largely dependent on the navigation of the ocean. The first vessel to cross the Atlantic fitted with steam power was the *Savannah*, of about 300 tons, which arrived at Liverpool from Savannah, in Georgia, in thirty days, partly under steam and partly under sail. Ocean steam traffic has been extending ever since. Two years ago I had occasion, in connection with my Presidential Address to the Institution of Civil Engineers, to collect some statistics with regard to shipping, and found that according to Lloyd's Register the largest British vessels then afloat were the twin-screw steamers *Oceanic*, of 17,274 tons, and the *Celtic*, of 20,904 tons, both gross register, built for the White Star line, and regularly making the passage between Liverpool and New York in seven days and eight days respectively; and the *Celtic* is still the largest mercantile steamship afloat, the tonnage of the new German steamer, *Kaiser Wilhelm II.*, being 19,360 tons gross register.

Unfortunately these fine ships, with many others, are now no longer owned in this country, although still flying the British flag. The latest German steamer on the American line, together with others recently launched from the Vulcan Works at Stettin, have maintained a speed averaging more than 23 knots, whilst the Cunard Company's liners—still, happily, English—the *Campania* and *Lucania*, built ten years ago, average 22 knots. This company is under contract with the Government to build two liners to maintain an average speed of $24\frac{1}{2}$ knots. The secretary of "Lloyd's Register of British and Foreign Shipping" has kindly supplied me with a list of the steamers of 10,000 tons and upwards which have been launched in the United Kingdom between 1900 and June, 1903. It is given in aggregate below:—

Year	No. of ships	Aggregate gross tonnage
1900	8	95,275
1901	8	107,396
1902	7	98,505
1903 (six months to June 30)	6	67,600 (approximate)

In the Address already referred to I mentioned the application as having been then recently made of the Parsons steam turbine to H.M. torpedo-boat destroyers. The South-Eastern and Chatham Railway Company's new steamer *The Queen* has been fitted with this class of engine of latest design. There is a central high-pressure turbine, driving its shaft at 700 revolutions a minute, and two side low-pressure turbines, each driving its separate shaft at 500 revolutions a minute. The steamer is 310 feet long, and is now running successfully in the service between Dover and Calais.

For some time past much attention has been paid, more especially in France, to the perfecting of submarine vessels for the purposes of naval warfare, but it cannot yet be said that they have passed beyond the experimental stage, although the advance made has been such as to cause our Admiralty to order several additional vessels of the submarine type. These vessels are to be propelled by internal-combustion engines when on the surface of the water and by electric motors when submerged.

Aëronautics.

Another of the attempted means of locomotion is that of aërial navigation. How little we appear to have advanced beyond where we were fifty years ago, when on September 24, 1852, that eminent French engineer, Henri Giffard, succeeded during an experimental ascent in Paris in driving a balloon against the wind for a very short distance, although on October 19, 1901, M. Santos Dumont was successful in navigating his balloon from St. Cloud round the Eiffel Tower in Paris and back to the spot where he had started only half an hour previously. Many have been engaged in this so far unsolved problem of aërial navigation, but there is one of whom we seldom hear. I will quote what Dr. Janssen said in his Presidential Address to the International Aëronautic Congress, held in France on September 15, 1900, regarding Mr. Langley, Correspondent of the Institute of France and Secretary of the Smithsonian Institution at Washington. "Independently of the fine and profound researches of this investigator upon the resistance of air, Mr. Langley has constructed an aëroplane which has progressed and has sustained itself during a time notably longer than any of the apparatus previously constructed."

In the last report of the Smithsonian Institution, that for 1901, it is stated that this steel flying-machine had a supporting area of 54 square feet, a weight of 30 lb., developed $1\frac{1}{2}$ horse-power, and repeatedly flew from one-half a mile to three-quarters of a mile. I cannot close this portion of my Address without referring to the death on February 7

last, in the ninety-fourth year of his age, of that eminent scientific aëronaut, Mr. James Glaisher, F.R.S., who in 1863 made his famous ascent to an altitude of seven miles, and who described at the Newcastle-upon-Tyne Meeting in that year, in an evening lecture, the balloon ascents made for the British Association.

Wireless Telegraphy.

In addressing this Section I feel that I ought to say a few words on the subject of "wireless telegraphy." With regard to signalling Signor Marconi certainly seems to have made progress. In January, 1901, signals were conveyed from Poldhu in Cornwall to the Isle of Wight, a distance of 200 miles, and in December of the same year, between Cornwall and St. John's, Newfoundland, a distance of 2000 miles. In the year 1902 signals were transmitted from England to the Baltic and the Mediterranean, which had thus passed over both sea and land. It seems to be not improbable that signals can be sent any distance, so long as the sending station can develop sufficient energy. The question of "syntonism," by which it is proposed to assure the secrecy of messages, appears to be still *sub judice*, but is undergoing further investigation.

There appears to be a practical field for the development of "wireless telegraphy," more especially where ordinary telegraphy cannot be applied, as, for instance, between shore and ships at sea or between one ship and another.

The Marconi Wireless Telegraph Company have obligingly furnished me with a list of eighteen land stations fitted on the Marconi system for commercial ship signalling, together with a list of forty-three passenger-steamers already furnished with the Marconi apparatus, thus affording evidence of its application to practical purposes.

The system of "wireless telegraphy" by Sir Oliver Lodge and Dr. Muirhead has, I understand, been fitted to cable steamers of the Eastern Extension Telegraph Company, to enable communication to be made with their cable stations.

SEWAGE DISPOSAL.

The bacterial treatment of sewage is receiving much attention, and by the courtesy of Mr. J. Corbett, M.Inst.C.E., the Borough Engineer of Salford, I am enabled to make a brief reference to the system of sewage treatment now carried on at the Salford Corporation Sewage Works, adjoining the Manchester Ship Canal. Twenty years ago the works were constructed with precipitation tanks for lime treatment of the sewage. After fourteen years of experiments with various precipitation and filtration processes, ten of the original precipitation tanks were formed into two large tanks in which precipitation takes place with the aid of milk of lime and salts of iron. The other two original tanks were converted into six roughing filters containing 3 feet in depth of fine gravel, to intercept particles which have escaped the precipitation process, and which would tend to choke the final filters. The final purification is on bacteria beds or aërated filters, with an open false floor of perforated tiles and large open culverts giving constant ventilation through the beds, some of which are filled to a depth of 5 feet and others to a depth of 8 feet with crushed clinkers of from $\frac{1}{8}$ inch to $\frac{1}{4}$ inch diameter. The liquid is "rained" on to the surface by spray jets, and the beds are used generally in shifts of two hours each for eight hours a day in dry weather and for twenty-four hours during heavy rainfall. An average quantity of from 400 to 500 gallons of sewage per square yard per day is treated with satisfactory results.

LIVERPOOL DOCKS.

Although there may seem little of interest in the vast areas of sand which separate Southport from the sea, yet if the whole sea coast from the Dee to the Ribble be taken into consideration, there are few areas of greater interest to the hydraulic engineer than these rivers with the shores that bound them, and few in which stranger changes in land level have occurred within historic times. In the Itinerary of Ptolemy, the Ribble is named immediately after the Dee, the Mersey being omitted altogether.

At the meeting of this Association at Liverpool in 1896, reference was made to these matters, not only by the President of this Section, Sir Douglas Fox, Past President Inst.C.E., but also in papers read, one of which, by Mr. T. M. Reade, F.G.S., is entitled "Oscillations in the Level of the Land, as shown by the Buried River Valleys and Later Deposits in the neighbourhood of Liverpool."

Evidence of the gradual sinking of the land is given by the very interesting discovery in 1850 of a Roman bridge at Wallasey Pool, Birkenhead. After excavating fourteen feet, the workmen came upon a bridge of solid oak beams, supported in the centre by stone piers and resting at the ends upon the solid rock at the sides of the creek. The length of the bridge was 100 feet and its width 24 feet, and the beams were each 33 feet long, 18 inches wide, and 9 inches thick; there were 36 beams formed into 12 compound beams, each 27 inches in depth. Careful drawings of this bridge were made by Mr. Snow, an engineer employed on the work then in progress. The drawings show that the rocky bed of the stream was some 13 feet below the bridge, which was itself about 16 feet below present high-water level.

Formerly Liverpool was one of the ports subordinate to the Comptroller of Chester, and is styled in the Patent "a creek in that port."

The first Act of Parliament authorising the construction of Dock works was obtained in 1709, and in 1853 the water area of the docks had been increased to 178 acres. Since 1853 the progress has been much more rapid, especially within the last thirty years. The total area of the docks and basins at Liverpool and Birkenhead is now 566 acres, whilst in connection therewith there are rather more than 35 miles of quayage. The marked tendency in recent years to increase the length, beam, and depth of ocean-going steamers has necessitated the provision of dock accommodation for a much larger class of vessel than formerly existed; and during the last decade works of great magnitude have been successfully carried out by the Mersey Docks and Harbour Board, under the able direction of the late Mr. G. F. Lyster, M.Inst.C.E., and, since his death, of his son, Mr. Anthony G. Lyster, M.Inst.C.E. In the northern section a new graving-dock has been constructed, extensive additions have been made to the Canada and Huskisson Docks, whilst the difficult work of constructing new river entrances has also been satisfactorily completed. In the southern section, the Queen's Dock has been enlarged and other important additions have been executed and brought into use.

To convey some idea of the magnitude of the works executed, it may be mentioned that the amount expended by the Dock Board in the extensions above indicated exceeds 1,750,000*l*.

The largest lock connected with the port of Liverpool is the Canada, 600 feet long by 100 feet wide, the sill being 14 feet below the datum of Old Dock sill, which datum is 4 feet 8 inches below Ordnance datum, or mean sea-level. Two large river-entrance locks into the Brunswick Dock are now approaching completion, the larger lock having a length of 350 feet and a width of 100 feet, with a sill 19 feet 6 inches below the datum of Old Dock sill.

One of the striking features in connection with the port of Liverpool is the difficult and extensive work connected with the dredging operations at the Mersey Bar. Since the commencement in 1890, to August, 1903, no less than 72,000,000 tons of material have been dredged and removed from the Bar and sea channels, and the average quantity for the last five years has been in round figures, 7,000,000 tons per annum. The total tonnage of the port for the year ended July 1, 1903, was 13,308,305, and the receipts therefrom amounted to 1,185,066*l*., exclusive of graving dock and other rates.

IRRIGATION.

This being the first Meeting of the British Association since the completion of the Assuan dam, which I had the opportunity to inspect when visiting Egypt in the early part of this year, I should like to devote to it a short portion of my Address. Those who desire to learn all about that work in detail I would refer to the papers (to which, indeed, I am indebted for my information on the subject) read before the Institution of Civil Engineers on January 27 last by Mr. Maurice Fitzmaurice, C.M.G., M.Inst.C.E., who had charge of the work on behalf of the Egyptian Government from its commencement in 1898 until December, 1901, and by Mr. F. W. S. Stokes, M.Inst.C.E.,

managing director of Messrs. Ransomes and Rapier, of Ipswich, who undertook the manufacture and erection of the sluices and lock-gates.

The Nile reservoir has been constructed for the purpose of impounding the water of the River Nile during the winter months, and discharging it in the months of May, June, and July, so as to supplement the ordinary flow of the river, and thus enable land to be irrigated which would otherwise receive either no water, or an insufficient supply. The situation chosen for the dam was the head of the Assuan cataract. There were various reasons for the choice: there was a wide section of the river, the waterway being about seven-eighths of a mile, thus permitting the construction of sufficient sluices at different levels to discharge the whole volume of the Nile in flood without weakening the dam by placing them too close together; the height of the dam would be moderate; the site chosen seemed to promise good rock foundation throughout, and there were several natural channels when the water was low, each of which could be dealt with separately if desired.

Arrangements had to be made to house and feed a population of 15,000; offices, workshops, a hospital, and other temporary buildings had to be erected, and a line of railway about 3 miles in length had to be constructed to connect the railway from Luxor to Assuan with the works at the dam. This preliminary work was carried out in 1898, and on February 12, 1899, H.R.H. the Duke of Connaught laid the foundation-stone of the dam.

To enclose the site of the permanent masonry dam, and to render it dry for the purpose of excavation and laying the masonry, temporary dams, known in Egypt as "sudds," had to be formed both above and below the site of the permanent dam. At low Nile the river at the Assuan cataract divides itself into five channels, and this work was done in five sections. The down stream "sudds" were first made, and consisted of stones. After the rush of water had been thus stopped, the up-stream "sudds" were formed of bags of sand.

It was found that the rock on the site of the dam was decomposed. The importance of a solid rock foundation was paramount, and to obtain it the excavation had to be carried down to a considerable depth, necessitating the removal of double the amount of material which had been contracted for, and the construction of nearly one and a half times the quantity of masonry that had been anticipated. The masonry, consisting of local granite set in Portland cement mortar, was commenced in May, 1900, was carried on vigorously during two working seasons in which the Nile was abnormally low, and was finished in June, 1902, less than 3½ years after the first stone was laid, and one year before the expiration of the contract time. The dam is nearly 1¼ miles in length, and the difference between the surface of the water on the up-stream side and that on down-stream side is 65½ feet when the reservoir is full. The masonry is pierced by 180 sluices, of which 140 are 23 feet high by 6 feet 6¾ inches wide and 40 are 11 feet 6 inches high by 6 feet 6¾ inches wide.

The construction of the dam having closed the river to navigation, provision for the passage of vessels was made by means of a canal formed on the west bank of the Nile and having a succession of four locks.

The capacity of the Nile reservoir when filled to the top water height of 348 feet above mean sea level is about 37,600 million cubic feet, a quantity which might have been greatly increased had not the desire to preserve the Temple of Philæ prevented the raising of the water to the level originally proposed. Even now many portions of the temple or its adjacent buildings are partially submerged.

It is anticipated that by allowing the whole volume of the Nile to pass through the sluices when most laden with mud during floods, the silting up of the reservoir to any considerable extent will be prevented. The cost of the works was nearly 2,450,000*l.* or about 10*l.* per million gallons of water impounded.

The original surveys and designs for the works were prepared by Mr. Willcocks (now Sir William Willcocks, K.C.M.G.), under the instructions of Lord Cromer and Sir William Garstin, Sir Benjamin Baker, K.C.B., K.C.M.G., F.R.S., Past President Inst.C.E., being the consulting engineer. On the retirement of Mr. Fitzmaurice, he was succeeded by Mr. C. R. May, M.Inst.C.E., as engineer in charge. The work was carried out by Messrs. John Aird and Co., as contractors, Mr. John A. C. Blue, Assoc.M.Inst.C.E., acting as their agent.

All concerned in the inception and execution of this great undertaking are to be congratulated on its successful and speedy completion, in the face of the many difficulties which were encountered and overcome.

WATER SUPPLY.

To everyone a plentiful supply of good water is not only a luxury, but almost a necessity of existence, yet how few even amongst the more intelligent of the millions who are accustomed to find such a supply ready to hand at the nearest tap have more than a very imperfect notion of the works that have to be constructed to obtain it, or the daily care and attention given to secure and maintain its purity, to ensure its efficient distribution, and to prevent its waste by careless, ignorant, or reckless consumers. It may therefore not be out of place that when the chair of this Section of the British Association happens, as now, to be occupied by one whose professional life has been largely associated with waterworks undertakings, he should address you on that subject, and endeavour briefly to direct attention to some of the main features of waterworks construction and management. In following that course I shall, however, necessarily have to describe what is already well known to at least a portion of my audience, on whose indulgence I must therefore rely.

Water supplies may be divided into two main classes, namely, "Gravitation" and "Pumping." In some instances a combination of gravitaiton and pumping is resorted to, especially in those cases in which the more elevated portions of the district to be supplied are situate above the gravitation level. In selecting a suitable source of supply the main points for consideration are the *quantity* and the *quality* of the water. The quantity should be such as will not only suffice to meet the requirements throughout the most protracted periods of drought and frost of the existing population to be served, but should provide for the probable growth of that population during a reasonable number of years to come. The quality of the water selected should be the best that can be obtained, having due regard to considerations of expense. The question of the altitude being sufficient to permit of a supply by gravitation is of far less moment than those of quantity and quality, because the difference in cost between water derived by gravitation and that obtained by pumping is, in the United Kingdom, less than is generally supposed; indeed, contrary to popular belief, gravitation water is frequently more costly than pumped water, owing to the much greater capital outlay usually incurred in the construction of the works for storing and conveying it.

Gravitation works may be divided into three classes, namely, those in which water is taken directly from a spring or stream without storage, those in which it is taken from a natural lake, in which case the surface level of the water is usually raised so as to increase the capacity of the lake as at Thirlmere, and those more numerous cases in which the water of a spring is impounded in an artificial reservoir generally formed by the construction of an earthen or masonry dam across the valley along which flows the stream to be taken.

In the more populated portions of England it is becoming more and more difficult to find an unappropriated gathering ground available as a source of water supply. The gathering ground, or drainage area as it is frequently termed, should either be free from human habitations and other sources of possible pollution, or any pollution arising therefrom should be capable of being efficiently disposed of by removal from the area of the gathering ground or otherwise.

The gathering ground must also possess a site suitable for the formation of an impounding reservoir. When this has been selected it next becomes necessary to ascertain the amount of the available rainfall, as recorded by rain-gauges situate in the drainage area or its immediate vicinity, or where these are not available, as deduced from the returns obtained from more distant rain-gauges, care being always taken that some at least of the gauges have been observed for a sufficient number of years to enable the true average rainfall to be determined. To store the whole of the water flowing from a gathering ground during a cycle of wet years in order to utilise it during a cycle of dry years would

entail the construction of reservoirs of enormous capacity, at a cost incommensurate with the object to be attained; it is therefore customary to make them of such size as to enable the supply to be maintained without risk of failure throughout the three driest consecutive years, the mean annual rainfall of which years generally amounts to about four-fifths of the average taken over a long period—say, forty or fifty years. From the mean rainfall of the three driest consecutive years a deduction must be made for loss by evaporation, which is usually between twelve and sixteen inches. The result is known as the available rainfall, and represents the quantity of water which can be drawn continuously from an impounding reservoir without fear of failure in the driest years. But the whole of this water can rarely be abstracted from a stream without injuriously affecting mill-owners or other riparian owners on the stream below the reservoir; therefore they have to be compensated for the injury they sustain. This is sometimes done by payments in money, but where the mills on the stream are numerous it is generally more economical to make compensation in water delivered into the stream immediately below the reservoir, because the same water compensates each mill in succession as it flows down the stream.

It has now become an accepted principle that one-third of the available rainfall flowing down a stream in a regulated quantity day by day throughout the year is of greater benefit to the mill-owners (with a few exceptions) than the whole of the rainfall allowed to flow in the irregular manner in which it is provided by nature. This compensation water is discharged from the reservoir into the stream either during certain hours on working days or by a uniform flow throughout the twenty-four hours of every day; a method now frequently demanded by County Councils on so-called sanitary grounds, but which is in my opinion not infrequently detrimental to the interests of mill-owners without a corresponding advantage to the public.

Where compensation in water is given there remains for distribution in the district to be supplied a quantity equal to only two-thirds of the *available* rainfall.

Assume for the sake of illustration a case in which the gross annual rainfall is 40 inches. Then we have:—

	Inches
Gross annual rainfall	40
Deduct to arrive at the mean annual rainfall of the three driest consecutive years—say one-fifth of forty	8
Mean annual rainfall of three driest consecutive years	32
Deduct for evaporation, say	14
Available for supply if no compensation water be given	18
Or if compensation water be given *deduct* one-third	6
Leaving available for supply	12

Having now ascertained the amount of the rainfall available for the supply of the district, it remains to be seen whether or not the area of the gathering ground above the reservoir is sufficient to give the required quantity of water. If it is not, the area may in some cases be extended by means of catch-waters in the form of open conduits cut along the sides of the valley below the embankment of the reservoir, and at such an elevation as will enable them to discharge the waters they collect into the reservoir above its top water line.

Almost all waters derived from gathering grounds are much improved by filtration before use for potable purposes. In some cities and towns in this country, more especially in Lancashire and Yorkshire, the benefit derived from filtration has not been sufficiently appreciated, and the water is still delivered into the houses unfiltered; but I am of opinion that the time will come when nearly every town of importance supplied with water derived from gathering grounds will adopt filtration, for it not only removes matters in suspension but it also diminishes the discoloration due to peat which is to be found in most moorland waters.

Reservoir dams in Great Britain consist either of earthen embankments or masonry walls. Of the former, examples of considerable size may be seen at the reservoirs of the Manchester Waterworks, designed by Mr. J. F. Bateman, F.R.S., Past President Inst.C.E., who was President of Section G of the British Association at the Manchester Meeting in 1861; and at the Rivington reservoirs of the Liverpool Waterworks, designed by my father, the late Mr. Thomas Hawksley, F.R.S., Past President Inst.C.E., who was President of this Section at the Meeting at Nottingham in 1866.

Earthen embankments are formed of the most suitable materials to be obtained by excavation in their neighbourhood; the water is retained by a wall of watertight clay puddle forming the core of the embankment, extending for its whole length and continued at each end into the natural ground forming the hillsides. This puddle core has to be carried down into the ground until watertight strata be met with, occasionally necessitating a puddle trench having a depth of 80 feet or more below the bottom of the valley and 200 feet or more in depth in the hillsides. Where the strata forming the sides of the valley are not watertight, it is necessary to continue the puddle core along the sides of the reservoir by means of wing trenches. The determination of the depth and extent of the puddle trench in order to secure the watertightness of the reservoir is one of the most difficult and anxious duties of the engineer on whom rests the responsibility of its construction. In forming his judgment he has to rely entirely on his experience for guidance, this being one of those matters which cannot be learnt at an engineering school or even in an engineer's office. How much depends on the exercise of a wise and trained judgment may be understood when it is realised that an error in this respect may result in very costly works having subsequently to be undertaken to stop an escape of water which might in the first instance have been prevented by a comparatively small outlay.

Provision has to be made for the passage of flood-waters during the construction of the embankment. This is ordinarily effected by the construction at about the level of the stream of a tunnel of sufficient diameter to convey with only a slight head the volume of water produced by the greatest flood which experience has taught us to anticipate. This tunnel is sometimes formed beneath the embankment, but preferably, where the circumstances are favourable, it is carried through the natural ground near to one end of the embankment. A shaft is built in connection with the tunnel, in which, after the embankment has reached its full height, are placed the outlet valves of the reservoir.

It is of the utmost importance that ample provision should be made for carrying off the flood and other surplus waters coming from the gathering ground when the reservoir is full, for if this be not done serious consequences may ensue, including the washing away of the embankment with resulting destruction of property and even of life. The surplus waters sometimes fall down a shaft erected within the reservoir, and make their escape by means of the tunnel previously mentioned, but more frequently they flow over a masonry weir and reach the stream below the embankment by means of a bye wash formed in the hillside. In my opinion the latter method is in most cases to be preferred, as being free from the risk of blockage by ice to which the shaft and tunnel are liable. Engineers are occasionally reproached with extravagance in the magnitude of the provision made for the escape of flood waters, but it must always be borne in mind that a *maximum* flood has to be provided for, such a flood as may occur only once in twenty or thirty years, but which must find a means of escape when it does occur, without danger to life or property.

Masonry dams are not so frequent in this country as earthen dams, partly by reason of their greater cost and partly because the geological conditions are generally not favourable to their formation, for not only do they require a supply of suitable stone near to hand for their construction, but they also need an incompressible foundation, such as rock or very strong shale. Any irregularity in the compression of the foundation occasioned by the weight of the dam would be liable to fracture the masonry of which it was built.

In the case of masonry dams a tunnel for the passage of flood waters during construction is formed at a suitable level in the masonry of the dam, and after completion of the work they are generally allowed to pass over the top

of the dam for the whole or a portion of its length, thus obviating the necessity for and the cost of an independent bye wash.

Whilst masonry dams have the advantage over earthen dams of not being liable to be breached by a waterspout, I am not aware of any case in which an earthen dam has been destroyed in that manner, and so far as I am able to form an opinion the accidents due to other causes have been as frequent in the case of masonry dams as in that of earthen dams. The destruction of masonry dams has in some instances been the result of too great reliance having been placed on theoretical calculations, without sufficient allowance having been made for the many defects in material and workmanship which might occur in a work of that kind. It was the opinion of the late Mr. Thomas Hawksley that in some cases the destruction of masonry dams had been occasioned by the neglect of the effects of uplift due to the pressure exerted by water finding its way beneath the bottom of the dam, a possible condition which he was very careful to take into account when designing the masonry dam of the Vyrnwy reservoir of the Liverpool Waterworks.

Examples of large masonry dams in the United Kingdom may be seen in that constructed by Mr. G. H. Hill at Thirlmere Lake, from which the city of Manchester is partly supplied with water. Also at the Vyrnwy reservoir of the Liverpool Corporation Waterworks, designed by and partially carried out under the direction of the late Mr. Thomas Hawksley, after whose retirement it was completed by Mr. G. F. Deacon, who presided over Section G on the occasion of the visit of the British Association to Toronto in 1897; and again at the reservoirs near Rhayader, in Wales, now approaching completion, from the designs and under the direction of Mr. James Mansergh, F.R.S., Past President Inst.C.E., for the supply of water to the city of Birmingham.

From the impounding reservoir the water has to be conveyed to the point of distribution by an aqueduct. This aqueduct, which is sometimes of great length, may consist either wholly of metal pipes, usually of cast iron, or partly of a conduit constructed of masonry, brickwork or concrete following the contour of the ground, with occasional tunnels where high ground has to be passed through, and metal (inverted syphon) pipes where valleys have to be crossed. These conduits may be either open or covered, the latter method being generally adopted, when they become what is technically known as "cut and cover" conduits. In the case of a continuous pipe-line of considerable length it is divided into sections by means of break-pressure tanks interposed at suitable elevations, each tank being say 100 feet or thereabouts below the preceding tank, by which means the pipes are relieved from the excessive pressure to which they would be subjected if the head due to the elevation of the impounding reservoir was carried forward to the service reservoir, from which the water is distributed to the consumer. Steel pipes are frequently used abroad where the cost of carriage is great, but they have not yet been much employed in this country, sufficient experience not having yet been gained in reference to the deterioration of steel pipes due to the action of the water from within and of the ground in which they are laid from without.

The lines of pipe are provided at intervals with suitable stopcocks, sluice-valves, and air-valves, and also in some cases with self-acting valves which close automatically in the event of the velocity of the water in the pipe becoming abnormally increased owing to the bursting of a pipe beyond.

I have already stated that most waters obtained from gathering grounds are much improved by filtration. The process of filtration may be carried on where the water leaves the impounding reservoir or at any convenient point on the line of conduit thence to the place of distribution, provided the filter-beds are situate at such an elevation as to place them on the line of hydraulic gradient. Various considerations will influence the determination of their position, but it is desirable that the water should not be subjected to long exposure to light after filtration. Filtration by the slow passage of the water through a bed of sand from two to three feet in thickness, supported by small gravel or other suitable material, is the method usually adopted in Europe, though what is known as mechanical filtration has been used to a considerable extent in the United States, and may under certain conditions be usefully employed. However I do not think it is likely to take the place to any considerable extent in this country of the efficient system of sand-filtration introduced so long ago as the year 1828 by the late Mr. James Simpson, Past President of the Institution of Civil Engineers. The rate of filtration, to be thoroughly effective, must depend on the condition of the water to be filtered, but a rate of from 450 to 550 gallons per square yard of surface of sand per day (*i.e.* twenty-four hours) is usually found to be efficient. Filter-beds are generally open to the sky, but occasionally, when situate at considerable elevations, they are covered by roofs to prevent interruption by the formation of ice in times of severe frost. In certain exceptional cases in which the water is difficult to treat it is twice filtered with excellent results. The water after filtration should be discharged into a pure-water tank or service reservoir of sufficient capacity to enable the process of filtration to proceed at a uniform rate by night as well as by day, without regard to irregularities in the rate of demand in the district of supply.

The particles in suspension in the water, which are intercepted by the process of filtration, gradually form a film over the surface of the sand, and thus improve the filtration; but this film at last becomes so thick as unduly to reduce the rate at which the water passes through the sand. The filter-bed is then laid off and, the water having been withdrawn, the surface of the sand is scraped off to a depth of about a quarter of an inch; the sand thus removed is washed in suitable machines to free it from the matter intercepted during the process of filtration, and is afterwards replaced in the filter-bed either immediately or after several similar scrapings have taken place, care being taken that the thickness of the sand left in the bed shall not at any time be reduced below that required to ensure efficient filtration. From time to time the sand is removed to a depth of several inches and washed, and occasionally it is taken out and washed to its full depth. From the foregoing description it will be understood that the filtration of water, although a simple process, is one which necessitates constant watchfulness on the part of those responsible for the management of those waterworks undertakings in which the water undergoes filtration.

As near to the termination of the aqueduct conveying the water from the impounding reservoir to the point of distribution as the levels of the ground will permit, a service reservoir should be constructed for the purpose of equalising the flow of water along the aqueduct, and for maintaining the supply to the district during any temporary interruption on the line of aqueduct due to a burst pipe or otherwise. The service reservoir should contain not less than one day's supply, two or three days, and, in exceptional cases, even more being sometimes desirable. Service reservoirs should by preference be covered so as to exclude light, and thus prevent the growth of vegetation which would otherwise take place. The covering, when consisting of brick arches, has also the advantage of keeping the water cool in summer, and preventing the temperature from becoming too much reduced in winter. The rate of draught on the service reservoir is continually varying throughout the day and night according to the hourly requirements of the population which it serves. This variation is very considerable, amounting during certain hours of the day to at least twice the average rate of consumption during the twenty-four hours. It will therefore be apparent that were it not for the equalising effect of the service reservoir the aqueduct must have a capacity at least double that which is needful where a service reservoir is available. At Southport, for example, although the water is distributed from a service reservoir, that reservoir is situate at a distance of about seven miles from the town, because, owing to the great extent of comparatively flat land in the neighbourhood of Southport, it was impossible to obtain a suitable elevation nearer to the town than Gorse Hill, on the summit of which the reservoir stands. Consequently the main pipes thence to the town have to be of sufficient capacity to convey the water at a rate corresponding with the demand at the time of *maximum* consumption, or, in other words, of about twice the capacity which would have been needed if the service reservoir could have been placed close to the town, when these pipes would, for the greater part of their length,

have been situate on the inlet instead of on the outlet side of the reservoir.

Having now followed the water in the case of a gravitation supply from its source to the service reservoir from which it is to be distributed to the consumers, it will be convenient to follow in a similar manner water obtained by means of pumping, leaving until later the consideration of its distribution, which, after it leaves the service reservoir, is common to both gravitation and pumped water.

Pumping supplies may be divided into two sections—first, those where the water is drawn from a source only slightly below the level of the pumping engines, such as where the water is taken from a stream or lake, or from culverts formed in gravel beds, or is discharged from impounding reservoirs situate at too low a level to enable the water to gravitate to the point of distribution; and secondly, where the water is raised from deep wells sunk in the sandstone, chalk, or other water-bearing strata.

In the first-mentioned cases the water has usually to be filtered, when it is generally found convenient to place the filter-beds at the pumping station, the water being firstly lifted (unless it will gravitate) on to the filter-beds, and secondly, after filtration, and by means of a separate pump, forced through pipes up to the service reservoir whence it is to be distributed.

In the case of deep wells, the water seldom, if ever, requires filtration, and is usually raised either directly or through pipes into the service reservoir, the total lift being frequently divided between lift pumps and force pumps with the object of balancing the work to be done by the engine.

Sometimes the well alone will yield a sufficient supply of water, but often it has to be aided by boreholes or by drifts or headings driven horizontally in the water-bearing strata near the level of the bottom of the well, and occasionally continued for a considerable distance, even as much as a mile or more from the well, the length of the headings depending on the quantity of water which can be profitably obtained from them, and also on other considerations too various to be mentioned here. There are cases in which it is possible to obtain sufficient water by boring from the surface of the ground and lowering a pump down the bore hole. The expense of a large well is thus saved, but it is, of course, impossible to augment the supply by drifting.

The time at my disposal will not admit of any observations on the merits of the various kinds of engines and pumps employed in raising water; they are not only very numerous, but each has to be considered in relation to its suitability for the particular circumstances of the case in question. Suffice it to say that, although most of the water pumped in the United Kingdom is raised by means of steam engines, water turbines, gas engines, oil engines, and (to some slight extent) electric motors are also employed. It may be mentioned that one of the largest oil engines in this country is engaged in pumping water from a deep well, and it is not improbable that gas and oil engines will in the future become more largely employed for waterworks purposes.

It should here be mentioned that there are a few instances in this country, and many in the United States of America, in which a service reservoir is dispensed with, and water is pumped directly into the main and distributing pipes of the district to be served, a method which, although employed with success, should not, in my opinion, be adopted where the circumstances admit of the use of a service reservoir. Where direct pumping is used, provision must be made to ensure continuous pumping day and night without intermission, so as to avoid interruption to the supply of the district, and the speed of the engines must be constantly varied to meet the demands of the consumers for the moment. The maintenance of uniformity of pressure in the main pipes may be assisted by the employment of large air vessels, or by accumulators such as are used for the supply of hydraulic pressure, or preferably by a combination of air vessels and accumulators.

We will now return to the service reservoir. When this reservoir is situate between the source of supply and the district to be supplied, it receives the whole of the water and delivers it into the district as needed for use; but when the district lies between the source and the service reservoir, it receives the excess of supply over consumption, and on the other hand makes good any deficiency during those hours when the consumption exceeds the supply. In either case this reservoir has the effect of equalising the flow from the source to the reservoir throughout the twenty-four hours of the day.

From the service reservoir the water is conveyed by one or more main pipes into the district of supply. These pipes are gradually reduced in diameter as they pass through the district, the water which they convey is taken off by other main pipes branching from them, and finally enters the service pipes, which are usually from five inches to three inches diameter, and are those from which the consumers' communication pipes are taken. The service pipes should in all cases be controlled by valves, so that the water can be shut off from them without interfering with the flow through the main pipes. Consumers' communication pipes are not generally allowed to be attached to pipes of greater diameter than five inches, and where a pipe of six inches diameter and upwards is carried along a street, another pipe of three or four inches diameter (preferably the latter size), and called a ryder pipe, is laid alongside to receive the attachments of the communication pipes. The ryder pipe is divided into lengths of from 350 to 400 yards, each of which is controlled by a valve at its junction with the main pipe. Hydrants for use in case of fire are attached to the ryder and other service pipes throughout the district at a distance apart not exceeding 100 yards. Except in streets where the houses are small and not high, it is desirable to lay the service pipes of not less than four inches diameter, not because a smaller pipe would not suffice to meet the requirements of the domestic consumers, but in order to ensure an ample supply of water in case of fire. When determining the sizes of the main pipes to be laid throughout a town, the engineer commences with the pipes most remote from the service reservoir, and gradually increases the diameter according to the probable number and magnitude of the supplies to be taken from them.

Pipes of cast iron having sockets run with lead and set up with a hammer are mostly used for waterworks purposes, but in some instances turned and bored joints put together without lead have been used with success, but these are only suitable where there is an unyielding foundation. I remember a case in Yorkshire, where turned and bored pipes were, much against the advice of the engineer, used for the distribution of gas in a colliery district, with the result that in a few years nearly every joint was leaking; fortunately the engineer had anticipated that result, and had laid the pipes with sockets in addition to the turned and bored joints; consequently, by opening the ground at each joint and running the joint with lead, the leakage was stopped without necessitating the relaying of the system of pipes. The main pipe of forty-four inches diameter, conveying water from Rivington to Liverpool, passes for several miles over a coalfield, and the ground has in places subsided over the coal workings as much as four feet without interfering with the supply of water; the ground having been opened at the pipe joints, the lead, which had been partially drawn from the joints, was forced back by hammering, and the joint was again made sound.

In some countries, where the cold is intense, water pipes have to be laid at a depth of from 10 feet to 12 feet below the surface of the ground to protect the water from frost, but in the United Kingdom a depth of from 2 feet 6 inches to 3 feet has been found to be sufficient even in very severe frosts.

Water, especially when soft, causes the interior of cast-iron pipes to become incrusted with nodules of iron, which reduce the effective diameter of the pipe and so diminish its capacity. This action is greatly retarded and in some instances entirely prevented by the application to the pipes, soon after they have been cast, of the coating introduced many years ago by the late Dr. Angus Smith, a process now nearly always employed.

It was at Southport that I witnessed the bursting of a main pipe, the only occurrence of the kind that I have seen during a period of forty years, of which a considerable portion has been spent amongst waterworks. Owing to the introduction of a new supply of water, the original main pipe was charged with water at a higher pressure than it had been intended to bear, with the result that several fractures occurred. I happened to be standing on one of

the roads at a little distance from the town when I heard a sound, and looking in the direction whence it came, saw in a field near by a black column rise vertically in the air for about forty feet in height. A girl who happened to be working in the field put her hands to her ears and fled, probably thinking she had seen Satan himself, but the column soon became clear, the black colour having been caused by the peat carried up with the water.

Having traced the water from its source to the door of the consumer, we now enter into another branch of the subject. Up to this point the water has been entirely under the control of the company or local authority by whom it is provided, but from the moment it enters the consumer's communication pipe, or where the communication pipe is the property of the water supplier, from the moment the water reaches the premises of the consumer, it comes under his control, subject only to such regulations and supervision as the Legislature has given the water supplier power to make and to exercise.

When water was supplied on the now almost obsolete "intermittent service," under which a town was divided into a number of districts into each of which in succession the water was turned for only one or two hours a day, the water suppliers paid but little attention to the fittings within the houses of the consumers, because, however great the quantity of water wasted through defective fittings, the waste could only last for the short time during which the water was turned on in each district, and it ceased altogether during the night.

About the year 1831 the system of "constant service," by which is meant a supply of water available from the pipes of the water suppliers at any moment throughout the day or night, was introduced into this country by the late Mr. Thomas Hawksley, at Nottingham, and it soon became evident that if a constant service was to be maintained the fittings within the houses of the consumers must be adapted to the new conditions and be placed under regulation and supervision. Suitable regulations were therefore formulated, and have since been improved and modified to meet modern requirements. These regulations, which are mainly directed to the use of proper pipes, taps and other fittings, and to service cisterns so constructed as to prevent a continuous flow and consequent waste of water, do not in any way limit the use of water by a consumer, who is at liberty to take as much as he requires whether by day or by night, nor does their strict enforcement inflict any hardship on the consumer, to whom good water fittings kept in a proper state of repair are in the end more economical than cheaper and inferior fittings requiring the frequent attendance of the plumber.

About five years ago, I had occasion to obtain statistics relating to the consumption of water in sixteen towns (including Southport) in England, containing an aggregate population within the district supplied of rather more than five millions of people, and found that the average quantity of water consumed in those towns for domestic purposes was 18¾ gallons per head per diem, showing what can be effected by good management and a careful observance of proper regulations for the prevention of waste without imposing any restriction on the quantity of water legitimately used. The figures which I have quoted as water for domestic purposes include the unmetered trade supplies and that comparatively small amount of waste which cannot be prevented, but do not include the water supplied by meter for trade purposes, the amount of which varies greatly in different towns, but being paid for by the consumer according to the quantity used may be disregarded when comparing the management of waterworks undertakings.

Some soft waters, more especially those derived from moorlands, have an injurious action on lead pipes and lead-lined cisterns, and are liable to cause lead poisoning in sensitive persons drinking the water, but this action is now commonly prevented by bringing the water into contact with lime before distribution.

In certain instances of public supplies, the hardness of the water is reduced by one of the several softening processes now in use, but it more frequently happens that the softening is effected by those consumers who require soft water for boiler or other trade purposes.

A few words with regard to the water supply of the town in which the Meeting of the British Association is now being held may not be out of place, the more especially when it is borne in mind that the rapid growth of its population during the last half century could not have taken place but for the introduction of a supply of good water.

The Southport Waterworks Company, by whom water was originally brought to Southport, was established under the authority of an Act of Parliament passed in the year 1854. Water was first obtained from a well sunk at Scarisbrick, about five miles south-east of Southport, a source which was practically superseded by another well which was a few years later sunk at the Aughton pumping station near Ormskirk. As the population to be supplied increased in numbers, the Company subsequently sank a third well, and constructed the still larger Springfield pumping station near Town Green, about nine miles south-east of Southport, and it is from the Aughton and Springfield wells, both sunk into the Bunter Beds of the New Red Sandstone formation, that the present excellent supply of water is derived. At each pumping station the water is raised by a pair of beam rotative steam-engines into two covered service reservoirs situate on the summit of Gorse Hill, near Ormskirk, at an elevation of 260 feet above ordnance datum, or in other words, above the mean level of the sea. From this reservoir the water is brought through two main pipes to Southport and Birkdale, which places have from the commencement of the undertaking had the advantage of a constant service. The late Mr. Thomas Hawksley acted as engineer to the company from its formation until his death in 1893, and I subsequently acted in that capacity until the transfer, under the powers of the Southport Water (Transfer) Act, 1901, of the undertaking of the company to the Southport, Birkdale, and West Lancashire Water Board, consisting of representatives of the Corporation of Southport, the Urban District Council of Birkdale, and the Rural District Council of West Lancashire.

The advances in recent years in chemical science, and the application of the science of bacteriology to the examination of water, have led to the condemnation of waters which a few years ago would have been deemed to be perfectly suitable for a town supply. Whilst fully appreciating the advantages to be derived from the most careful examination of water supplied for domestic consumption, I cannot but think that we are sometimes unnecessarily alarmed by the results obtained. Taking a broad view of the subject, and looking to the healthy condition of towns which have for many years been supplied with water from sources now regarded with suspicion, I venture to think that the teachings of chemistry and bacteriology are as yet but imperfectly understood, and that in the future it will be found that some waters now considered of doubtful character are perfectly good and wholesome. I am well aware that the expression of these views may call forth the indignation of some of my friends amongst eminent chemists and bacteriologists to whose opinions on such subjects I feel bound to pay deference. A Royal Commission has recently recommended that a Government department be established and endowed with enormous powers of interference with the action and discretion of the bodies entrusted by Parliament with the responsibility of the administration of water supplies, and it behoves those bodies to give careful consideration to that recommendation, and to take such steps as may be necessary to check any attempt to give effect to a proposal which may result in committing them to the carrying out of unreasonable requirements, possibly involving needless expenditure, at the bidding of a Department from whose dictum they may have no appeal.

Although a matter only indirectly connected with water supply, I think it may be of scientific interest to this Section to have brought to their notice the case of the River Rede in Northumberland, which takes its rise in the Cheviots. At a place called Catcleugh, about four miles below the source of the Rede, its waters are diverted by the Newcastle and Gateshead Water Company for the supply of their district. The gathering-ground above the point of diversion is about 10,000 acres in extent, and the quantity of water taken is ascertained by means of a gauge, and registered continuously by a recording instrument. An inspection of the diagrams taken during periods in which there was no rainfall shows a daily variation in the volume of water flowing down the river. For example, during a period of eight days (June 9 to 16, 1899) without interruption by rain,

the gradual rise and fall of the river was almost regular, day by day, the maximum flow occurring about 9 a.m., and the minimum about 9 p.m., the difference between the two amounting to nearly 10 per cent. of the total quantity passing down the river at the time of minimum flow. Various suggestions as to the cause of this phenomenon have been made, but I am unable to give any satisfactory explanation. It occurs in winter as well as in summer, and may take place daily throughout the year, though it cannot be observed except during dry periods. It may well be that a similar phenomenon occurs in other rivers, but has escaped observation owing to the absence of recording gauges.

THE INTERNATIONAL GEOLOGICAL CONGRESS.

THE ninth gathering of the International Geological Congress was held this year in Vienna. After a preliminary series of excursions through different parts of Austria-Hungary the members assembled in the rooms of the University on Thursday, August 20, when the meeting was inaugurated by the Archduke Rainer and the Minister of Public Instruction. According to the programme prepared by the committee of organisation, each alternate day was to be devoted to the reading and discussion of papers on given subjects of general interest, while the intervening days were given up to excursions in the neighbourhood of the imperial city. After the formal opening of the congress, the afternoon of the first day was spent, under the presidency of Mr. Emmons, of the United States Geological Survey, in receiving a miscellaneous group of communications, including a paper on the Laccolites of the Aar-massif by Prof. Baltzer, and an account of the recent volcanic eruptions of Martinique and St. Vincent by Mr. E. O. Hovey, illustrated by an excellent series of photographic lantern slides. The next day of discussion (August 22) was dedicated to the crystalline schists, under the chairmanship of Prof. Zirkel in the morning and Prof. Loewinson-Lessing in the afternoon. Until the various communications are in print and can be studied and compared, it is hardly possible to say how far they have advanced our knowledge of the subject. The speakers on this and subsequently on the other selected subjects of discussion showed a prevailing tendency to dwell on the local peculiarities of the regions most familiar to them, and rather to lose sight of the general principles to which local observations should properly lead. The crystalline schists of Germany, Austria, the Alps, Finland and North America were all brought into review, so that a sufficiently wide basis was provided for satisfactory generalisation. The third day (August 24) for the reading of papers, under the presidency of Sir Archibald Geikie in the forenoon and Prof. Heim in the afternoon, was spent in listening to essays by various geologists on the important phenomena embraced under the general designation of "overthrusts." MM. Lugeon and Haug described the structures displayed in the Alps, Prof. Uhlig those of the Carpathians, Mr. Bailey Willis those of the United States. In an interesting discussion Prof. Heim indicated that he surrendered the so-called "double-fold" of the Glärnish, as originally advocated by him, and now admitted that the structure implied a gigantic overthrust. Prof. Rothpletz, who has long maintained this view, also took part in the debate, which at times became lively from the energy of the speakers and the difficulty which they found in confining their exuberance within the limits of time prescribed by the council. Though the doctrine of overthrusts was admitted, considerable divergence of opinion appeared as to the true nature and origin of the structure.

Wednesday (August 26) was dedicated to a consideration of the geology of the Balkan peninsula and the East, under the presidency of Prof. Barrois in the forenoon and Prof. Tschernyschew in the afternoon. An interesting and important series of papers was read, in which the present state of our knowledge of these regions was detailed by those geologists to whom the recent advance of that knowledge has mainly been due.

On Thursday (August 27) the morning was taken up in the reception of miscellaneous communications in four different rooms of the University. As this extensive building includes a large number of rooms separated from each other by staircases and passages, and as no adequate system of placards was adopted to guide the members to these various meeting-places, much time was lost in trying to find them, and in some instances the search was abandoned in despair. The afternoon was devoted first to the reception of the reports of the various Commissions appointed by the congress at previous meetings. A satisfactory statement was made by Prof. Beyschlag as to the progress of the international geological map of Europe. Sir Archibald Geikie gave in the report of the Commission on lines of raised beach in the northern hemisphere and also that of the Commission on international cooperation in geological research. On his proposal it was agreed to form a small committee for the purpose of collecting information from different countries with a view to combined effort in those branches of inquiry which are not purely geological but require the services of other sciences. The first number of the "Palæontologia Universalis" was laid before the meeting by M. Oehlert, who was warmly congratulated on the successful launching of this enterprise. The report of the Commission on glaciers was presented by M. Finsterwalder. The recommendation of the committee appointed to consider the Spendiaroff prize was unanimously adopted, that the prize should be awarded to Prof. Brögger, of Christiania. The last official act of the congress was to choose the next place of meeting, which, by a majority, was fixed to be Mexico.

A very unpleasant impression was made on a number of members of the congress by the action of the Vienna committee of organisation in regard to the next meeting place. So far back as March last the general secretary wrote to Dr. Bell, acting director of the Geological Survey of Canada, asking whether an invitation could be sent from Canada to hold the next meeting of congress there, and assuring him that many Austrian geologists would be very pleased to visit that country and would be happy to support the invitation at the approaching Vienna meeting. No mention was made in that letter, or in any subsequent communication, that applications had been sent to any other country. Dr. Bell replied in the same month of March that he cordially welcomed the proposal and would do all in his power to further its acceptance. The Geological Survey and the Royal Society of Canada warmly supported it, and eventually the Government authorities took it up and Parliament actually voted 25,000 dollars towards the necessary expenses of the meeting. Dr. Bell was commissioned to proceed to Vienna and personally invite the congress to hold their next session in Canada. On arriving in Vienna, however, he found that, unknown to any one in Canada, the committee had also been simultaneously in treaty with Mexico, and without writing to know what was being done in Canada had inserted in the official programme an invitation which had in response been received from Mexico. He soon saw that though the committee could not bind the congress, they had practically decided the question in favour of Mexico so far as their votes and influence could go. The Canadian authorities naturally feel indignant at such treatment, and it will excite no surprise if they are in no hurry to renew their invitation should the visit to Mexico fail of accomplishment.

Excursions have always formed a prominent part of the work of the geological congress, and this year they have been organised on a greater scale than ever before. Not only was there a diversified series set on foot before the meeting and another after it, but half the time of the congress in Vienna was devoted to excursions in the neighbourhood. Whether these miscellaneous parties contribute as much as might be desired to the enlargement of the geological experience and knowledge of the congressists, they at least have one excellent result inasmuch as they bring together scientific friends who have seldom a chance of meeting each other and, likewise, enable them to make the personal acquaintance of men with whose writings they may have been long familiar. Indeed, it may be asserted that the fostering of such personal acquaintance is perhaps the most practically valuable part of the work of the congress. For the enlightenment of the excursionists an admirable Livret Guide to Austrian geology was drawn up by Dr. Teller. Of this publication an account will be given in another issue of NATURE.

NOTES.

PROF. GRAHAM KERR has just received a letter from Mr. J. S. Budgett in which the latter announces that he has solved the important problem of the development of Polypterus. The letter is written from southern Nigeria and dated August 28. It appears that Mr. Budgett has been able to fertilise a large quantity of eggs of *Polypterus senegalus*, and that the early development is "astoundingly frog-like"—segmentation being complete and fairly equal, and the process of invagination resembling that of the frog's egg. Prominent neural folds are formed which arch over in the normal fashion. Mr. Budgett had already made three expeditions to various parts of tropical Africa in his endeavour to obtain material for studying the development of Polypterus, and zoologists will rejoice that his efforts have been at last attended with success. The Crossopterygians have been for some time the most important vertebrate group awaiting the investigation of the embryologist, and the results gained by Mr. Budgett in the working out of his material in the laboratory will be looked forward to with the greatest interest by all vertebrate morphologists.

A MOVEMENT is in progress for erecting a memorial of James Watt, and at a meeting recently held it was decided that the form the memorial should take should be an institution for scientific research, and an appeal is now being made for funds to carry out the project. Mr. Andrew Carnegie, who is the secretary for America, has promised a subscription of 10,000*l.* towards the object.

THE Bombay University Syndicate announces that the subject selected for the Dr. Theodore Cooke memorial prize for 1905 is "Electric Traction and the Application of Electricity to the Requirements of Cities in India." Competitors for the prize should be graduates in engineering of the University of Bombay of not more than seven years' standing.

THE second International Congress of Philosophy is to be held in September of next year in Geneva.

THE fourth International Congress of Psychology will, it is stated, meet in Rome in the spring of 1905, instead of in the autumn of 1904, as had been arranged.

DR. LOUIS PARKES has been appointed to succeed the late Prof. Corfield as consulting sanitary adviser to H.M. Office of Works.

THE forty-eighth annual exhibition of the Royal Photographic Society opens to-day at the New Gallery, Regent Street. The exhibition will remain open until October 31.

FURTHER trials on the electric railway at Zossen have resulted in a speed of nearly 114 miles an hour being attained.

AN exhibition of the pathological specimens which have been added to the St. George's Hospital Museum during the past year will take place at the museum from October 1 to 17.

THE death is announced of Mr. Washington Teasdale, of Leeds, at the age of seventy-three. He was a fellow of several scientific societies, and president of the Leeds Astronomical Society.

A REUTER telegram from Santiago de Cuba announces that a shock of earthquake, the most violent since 1885, occurred there on the morning of September 19, and lasted fifteen seconds.

THE death, at the advanced age of eighty-five, is announced of Dr. Alexander Bain, who for twenty years occupied the chair of logic in the University of Aberdeen, and was a voluminous writer on language, logic, psychology, and kindred subjects.

IT is stated by Reuter that the private subscriptions towards Captain Bernier's projected North Pole expedition amount to 12,000*l.*, of which Lord Strathcona has given 1000*l.* It is also stated that the Canadian Government will probably build and equip the vessel for the expedition.

A PROVINCIAL sessional meeting of the Sanitary Institute will be held at the University of Birmingham on Saturday next, September 26. A discussion on some practical considerations in connection with modern methods of treating sewage will be opened by Prof. A. Bostock Hill and Mr. J. E. Willcox.

THE Colonial Economic Committee of Berlin announces that the utility of the gutta-percha discovered by the expedition which was undertaken to New Guinea under the leadership of Herr Schlechter has so far been established that the gutta-percha from the low-lying country may be regarded as suitable for cable purposes as an admixture, and, if carefully obtained, be fit for cables in a pure condition. Large quantities of gutta-percha have been obtained from New Guinea, and are at present being tested, the Secretary of State for the Imperial Post Office having granted a large sum of money for the purpose. It is proposed by the Colonial Economic Committee to establish a gutta-percha enterprise for the education of the native population of New Guinea in the cultivation of gutta-percha and its winning. This will take the form of a fresh expedition under Herr Schlechter for a period of three years. Assistance will be given by natives of Borneo and others familiar with the question of rubber production.

A SUCCESSFUL journey through eastern Mongolia (supplementing a more extended journey accomplished last year by Mr. Campbell, Chinese Secretary of the British Legation) has, says a Peking correspondent of the *Times*, just been completed by Mr. Claude Russell and Mr. Hicks Beach. The party left Peking on July 20, and, passing through Jehol, struck north to the Manchurian Railway at Tsitsihar, which was reached in forty-eight days. Their route lay east of the Khingan Mountains, the distance covered, 1000 miles, being to a considerable extent, so far as is known, through country not previously visited by any European. The travellers rode on ponies, with pack mules for their baggage. They had four servants, but no escort. They met with unfailing courtesy from all classes, both Mongols and Chinese. The country is thinly peopled, but is being gradually colonised by Chinese from within the Great Wall.

A BRITISH and International Aëronautical Exhibition, organised by the Aëronautical Institute, was opened at the Alexandra Palace on Thursday last. Among the exhibits are a model balloon, and kites and specimens of balloon accessories sent by the German Government, examples of Mr. S. F. Cody's kites and his gear for flying them, various flying machines either full size or in model form, and the large machine which Dr. Barton is constructing. In connection with the exhibition three competitions are to be held, silver and bronze medals being awarded to the two winners in each. The first is for kites, and in judging consideration will be taken of the way in which the kite leaves the ground, the manner in which it ascends, its steadiness, the time required to let out the whole mile of wire or string, the altitude attained, and the

rapidity and manner of descent. The second competition is also for kites, and is organised with a view of ascertaining the best and safest form of aëroplane for man-lifting kites and dynamic flying machines. The third competition is for parachutes.

IN the *Atti della Fondazione Scientifica Cagnola* (vol. xviii.), Prof. Grassi gives an excellent survey of our present knowledge of malaria. He describes fully its epidemiology and prophylaxis, and the morphology and development of the malaria parasite. In the latter connection he introduces some new terms. The asexual parasites producing the febrile attacks are named "monogonia," the developmental forms in the mosquito "amphigonia," while the recurrent attacks of fever which occur at long intervals after infection are regarded as being due to parthenogenetic parasites, which develop from the non-flagellating (female) sexual cells, or gametocytes.

THE first volume of reports of the Sleeping Sickness Commission of the Royal Society has just been issued. In report No. 1 Dr. Aldo Castellani describes his discovery of the presence of a trypanosoma in this disease (see NATURE, lxviii., p. 116). Report No. 2 is a "progress report" by Lieut.-Colonel Bruce, F.R.S., and Dr. Nabarro, who have continued the work of Dr. Castellani, and they confirm his discovery of the presence of a trypanosoma in the cerebro-spinal fluid of sleeping-sickness. In every one of forty cases examined the trypanosome was found, even in the early stages. In fifteen cases of other diseases the trypanosome was not observed, so that the parasite is not present in the cerebro-spinal fluid of the general population. In the blood also of sleeping-sickness the trypanosome is practically always to be met with. In six individuals suffering from fever, but presenting no symptoms of sleeping-sickness, trypanosomes were also detected in the blood but not in the cerebro-spinal fluid. The question arises whether the trypanosome found in the blood of these six cases was the same species as that present in sleeping-sickness. Morphologically there are certain differences between the two, but the results of inoculation experiments are up to the present indefinite. The distribution of sleeping-sickness in Uganda is striking, the disease occurring only in a belt of country fifteen miles wide on the northern shores of the Victoria Nyanza. In this district a tsetse fly (identified as *Glossina palpalis* by Mr. Austen, of the British Museum) was observed to be very abundant, and the question is raised whether this fly conveys the infection in sleeping-sickness, just as one does in the tsetse disease of horses, &c., which is also due to a species of trypanosoma. Flies, freshly caught, were allowed to bite a monkey, and in five days trypanosomes were found in its blood, showing that the flies do convey trypanosome infection, though whether the sleeping-sickness species it is not yet possible to say. The report concludes with the clinical histories of a number of cases of the disease, and is illustrated with ten plates.

WE have recently received meteorological "Yearbooks" (1) from Dr. H. Hergesell, director of the service of Alsace-Lorraine, containing hourly observations for Strassburg and summaries at various other stations, for the year 1899; and (2) from Dr. P. Berghaus, containing hourly observations for Bremen, and rainfall statistics at a few stations. The observations and results of both "Yearbooks" are carefully prepared according to the uniform system adopted for all the States of the German Empire.

DR. G. HELLMANN has published a rain chart of the Prussian provinces of Hessen-Nassau and Rheinland, including Hohenzollern and Oberhessen, together with a discussion of the rainfall statistics for the last ten years. This work is the eighth of the valuable series prepared by him at the request of the Berlin Meteorological Department, to which we have before referred in our columns. The tables contain mean annual values of rainfall, monthly percentages of those values, the greatest falls in short periods, and other useful information.

IN a paper read before the Royal Society of New South Wales, Mr. H. C. Russell clearly disproves a somewhat common belief that a wet season in England is followed by a wet season in Australia. A diagram illustrating the paper shows that, although sometimes heavy rains in England will be followed next year by heavy rains in Australia, they seldom do so. Mr. Russell finds that, from 1880 to 1885, and from 1894 to 1901, for instance, rain was abundant in England, while Australia was suffering a severe drought.

A PAPER read before the South Staffordshire and East Worcestershire Institute of Mining Engineers by Mr. F. G. Meachem deals with underground temperatures. The mean increase in temperature, deduced from the summary of the results collected by the British Association committee and published in 1882, was 1° F. for a descent of 64 feet. Since 1882 other important observations have been made, from which it appears that the highest rock-temperature obtained at a depth of 4580 feet (Calumet and Hecla Copper-mines, Lake Superior) is 79° F., the temperature at a depth of 105 feet being 59° F. The difference of temperature in the column of 4475 feet of rock was 20° F., averaging 1° F. for every 224 feet. The average annual temperature of the air where the observations were made is 48° F., and that of the air at the bottom of the shaft is 72° F. The mean increase obtained by the observations of Mr. H. A. Wheeler at other mines in the Lake Superior district in 1886 was, however, 1° F. in 100·8 feet. Mr. Meachem has made various temperature-tests at Hamstead Colliery extending over several years, and all observations show an increase of temperature in undisturbed strata of 1° F. for every 110 feet of descent beyond 65 feet from the surface. It has been found that the temperature of the undisturbed strata at the pit bottom, 1950 feet below the surface, is 66° F. This was ascertained by inserting a maximum and minimum thermometer, protected by a metal case, into a bore-hole driven 10 feet into freshly-cut coal. The hole was closed with clay and left for various periods from one to fourteen days. Repeated observations led to the result stated. It is concluded that by sinking larger shafts and introducing more efficient ventilating machinery, miners will be able to do as much work at a depth of 3000 feet as is now done at a depth of 1000 feet, and that mining engineers will be able to reach any depth at which coal is likely to be found in this country and work the same.

WE have received the second fasciculus (with plates 13–24) of Dr. E. A. Goeldi's "Album of the Birds of Amazonia" (*Album de Aves Amazonicas*), in course of publication by the Museum Goeldi, at Para. The plates of this part, which, like their predecessors, are coloured, include selected representatives of the Cotingidæ, Psittacidæ, Cœrebidæ, Picidæ, Formicariidæ, Cuculidæ, Dendrocolaptidæ, Cracidæ, &c., and likewise depict those extremely characteristic South American birds, the trumpeter, seriema, horned screamer, ruddy tinamu, and rhea. The latter bird, it may be mentioned, is commonly known by Europeans in Brazil as the emeu (ema), while it may also be noticed that the native name anhuma might conveniently be adopted in ornithological literature for the screamers. The plates

depict, so far as possible, the birds in their natural surroundings, and although in some perhaps a trifle too gaudy, the colouring appears to be very true to nature. When complete, the book should be invaluable to all interested in the birds of Brazil.

ANOTHER illustrated work recently to hand (although the cover is dated 1902) is part x. of the atlas of the section devoted to Crustacea in "Illustrations of the Zoology of the *Investigator*," by Major Alcock and the late Mr. A. F. McArdle. This part includes plates lvi.–lxvii., the majority of which illustrate crabs, although some crawfishes are also figured. In the absence of the text, fuller notice is difficult.

THE Boston (U.S.A.) Society of Natural History is to be congratulated on the decision to publish an annual summary of the work done on the land mammals of North America. The part just issued, dealing with the years 1901 and 1902, forms No. 3 of the Society's *Proceedings*, and is compiled by Messrs. Miller and Rehn. With the aid of such annual summaries naturalists in other countries may hope to keep abreast of American work in this department of zoology.

WE have received the second part of vol. xiv. of the *Natural History Transactions of Northumberland, Durham, and Newcastle*. It contains the presidential addresses for the years 1901 and 1902, both of which set an excellent example in that they deal exclusively with local subjects. The committee records with regret the determination of the Tyneside Naturalists' Field Club to terminate its connection with the Society, which has existed since the year 1864; this feeling of regret will, we think, be widespread, especially as it will involve in the near future a severance of the *Joint Transactions* of the two bodies.

ARTICLE two of vol. xvii. of the *Journal* of the College of Science of Tokyo contains an account of a worm (*Ceratocephale osawai*) which, at certain seasons, appears in swarms in the Gulf of Tokyo and the rivers debouching therein, after the manner of the palolo worms of the South Pacific and the Atlantic. Instead, however, of belonging to the Eunicidæ, the Japanese species, which is regarded by its describer, Mr. A. Isuka, as new to science, is referable to the Lycoridæ. According to the experience of the fishermen, which is confirmed by Mr. Isuka's personal observations, the Japanese "palolo" swarms during the months of October and November, usually in four periods of a few days' duration each. The swarming season always takes place when the moon is either new or near the full, and invariably occurs in the evening just after flood-tide. On the occasion of the author's observation, the height of the swarm did not last more than a couple of hours, the worms after this apparently sinking to the bottom exhausted.

THE collections of plants made by Mr. J. N. Rose in Mexico and Central America have not only added a number of new types, but have yielded several plants which are likely to be of horticultural value. In an account, the third which has appeared in the *Contributions* from the United States National Herbarium, attention is directed to two new bulbous species of Polianthes, and a Crinum. Of the genus Argemone the author has obtained eleven species, including the three well-known cultivated species of which wild specimens are rare, even in herbaria.

THERE is very considerable difficulty in obtaining information concerning the botany of Siam, and the reason for this appears to be that no collectors have attempted to work the country systematically. Mr. F. N. Williams has written a short article on this subject in the current number of the *Journal of Botany*, in which he enumerates the few collections of Siamese plants which he has discovered in the Kew Herbarium. Almost as little known is the algal vegetation of the Shetland Isles, for which the only records date back to the year 1845. A list of the marine algæ collected by Mr. Börgesen—together with those previously recorded—is contributed by him to the same journal.

THE growth of canker-areas on trees has been attributed by some investigators to frost, and by others, including Hartig, to the ravages of the fungus *Nectria ditissima*. The suggestion made some years ago that bacteria were the cause of disease has not met with much support from pathologists. In the *Bulletin International de l'Académie des Sciences de Cracovie*, Mr. J. Brzeziński adduces fresh evidence in favour of this view so far as apple, pear, and hazel trees are concerned. After unsuccessful attempts to set up disease in sound tissues by infection with Nectria, the author sought for the origin of disease in the bacteria which are abundant in the wood elements. It was not difficult to get pure cultures, and after inoculation with the bacteria discoloration and destruction of the tissues soon followed. Canker spots were not produced, but it is probable that they would not develop in the space of time during which the experiments were conducted.

A REPORT has recently been issued by the Foreign Office giving the result of inquiries made by His Majesty's ministers as to the navigable inland water-ways in France, Belgium, the Netherlands, Germany, and Austria-Hungary. The reports are necessarily statistical, but at the same time contain a great deal of useful information. Each of the above countries has expended out of State funds during the past twenty-five years very large sums in improving the inland navigation either by deepening and improving the natural rivers, or, where this was not practicable, by canalising them, or by the construction of new water-ways. Mr. Hugh O'Beirne, who drew up the report relating to France, has arrived at the conclusion that, taking into consideration the cost of improving the water-ways, which varies from 14,924*l*. to 64,516*l*. per mile, it would have been cheaper and more advantageous to have constructed railways. Mr. Robinson, the reporter for the Netherlands, directs attention to the use of petrol motors for moving the boats, and says that the number of small steamers and tugs employed on the water-ways has immensely increased in Holland, and that water transport seems to be on the verge of a revolution owing to the introduction of the cheap, small and practical petroleum motors which can be fitted to almost every description of craft.

A NEW edition—the third—of "The Figures, Facts and Formulæ of Photography" has just been published by Messrs. Dawbarn and Ward, Ltd. The work has been considerably enlarged, and now has an index.

WE have received a copy of the map and report on the auriferous quartz reefs of Cue and Day Dawn in the Murchison Goldfield of Western Australia, by Mr. W. D. Campbell (*Bulletin* No. 7 of the Geol. Survey, W.A.). The reefs lie in areas of granite, diorite and amphibolite.

THE ninth edition of the well-known "Bloxam's Chemistry," revised and rewritten by Prof. J. M. Thomson, F.R.S., and Mr. A. G. Bloxam, has been published by Messrs. J. and A. Churchill. The work retains its characteristics

as a convenient, though necessarily condensed, account of essential points in inorganic and organic chemistry, and it will doubtless remain a popular volume of ready reference for students.

MESSRS. C. GRIFFIN AND CO. have published a second edition of the late Dr. Alder Wright's work on "Animal and Vegetable Fixed Oils, Fats, Butters, and Waxes," edited and partly rewritten by Mr. C. A. Mitchell. The scope of the work has been extended in the direction of the requirements of practical chemists, more details being given of analytical methods and processes for detecting adulteration of individual oils. The systematic description of tests for adulteration occupies 222 pages, and consists almost entirely of new matter.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. A. F. Putz; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Dr. S. Carew; a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mr. Frank Ree; a Getulian Ground Squirrel (*Xerus getulus*) from Morocco, presented by Mr. D. Seth Smith; two Green Lizards (*Lacerta viridis*), European, presented by Mr. R. E. McLaren; a Chimpanzee (*Anthropopithecus troglodytes*, ♂) from West Africa, two Suricates (*Suricata tetradactyla*) from South Africa, an Indian Coucal (*Centropus rufipennis*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

THE ROTATION PERIOD OF SATURN.—In No. 3900 of the *Astronomische Nachrichten*, Mr. W. F. Denning gives a *résumé* of his observations of the white spots which have been visible on Saturn since July 1; out of thirty-two observing nights only seven were recorded as giving "good seeing." Mr. Denning finds it difficult to reconcile the rotation period observed with that usually given, *i.e.* 10h. 15m., but finds that a period of 10h. 39¼m. agrees with the observations much better. As the mean of many observations of seven of the markings, he obtains the period 10h. 39m. 21·1s., so that if the bright spot discovered by Prof. Hall in December, 1876, near to the equator of Saturn, really represented, in its period of 10h. 14m. 23·8s., the rotation of that part of the planet, there is a difference of 25 minutes between the equatorial and the north temperate currents, the latter being the slower; this is in accordance with the Jovian phenomena, where the north temperate markings take 5½ minutes longer for one rotation than do the equatorial markings.

A collection of the observations, made by various observers, of Barnard's large white spot indicates a rotation period of 10h. 38m. for that region of the planet.

NEWLY DETERMINED STELLAR RADIAL VELOCITIES.—From spectrograms obtained at Potsdam with the spectrograph No. iv., in conjunction with the 32·5cm. refractor, Prof. Vogel has determined the radial velocities of β Arietis, ω Ursæ Majoris, and ϵ Ursæ Majoris. From measurements of the magnesium line at λ 4481, he has found the relative velocity in the line of sight of the components of β Arietis to be between 60 and 70km., of ω Ursæ Majoris about 45km., and of ϵ Ursæ Majoris about 15–20km. (*Astronomische Nachrichten*, No. 3898).

REPORT OF THE CAPE OBSERVATORY.—In his report of the Cape Observatory for the year 1902, H.M. Astronomer, Sir David Gill, refers to several additions and improvements of the instrumental equipment.

The new 24-inch Zeiss objective prism, presented to the observatory by Dr. Frank McClean, F.R.S., is now ready for mounting, and has a refracting angle of 11¼°.

The oppositions of Uranus, Saturn, Jupiter, and Neptune were observed with the heliometer, and 476 observations of α Centauri were made in connection with a redetermination of the parallax of that star undertaken by Messrs. Cookson and Lowinger.

Two hundred and eighty successful spectra of stars ranging in magnitude from 3·5 to 5·5 were obtained with the 24-inch "Victoria" telescope fitted with the "Grubb" objective prism.

In connection with the astrographic chart work 522 triple charts have now been taken, and 434 plates, containing 248,921 stars, have been completely measured up to date.

The geodetic survey of South Africa is being carried out despite climatic difficulties, but the determination of the Anglo-German boundary in south-west Africa has been delayed by the imperative necessity for giving the workers a rest and a change of climate; the whole of the triangulation is, however, complete.

LIVERPOOL ASTRONOMICAL SOCIETY.—The first annual report of this society shows that a successful session has been held. The Society possesses a fine 5-inch equatorial by Cooke and Sons, of York, a 3-inch transit instrument, a sidereal clock, and a valuable library.

Amongst the papers read during the session, and summarised in the report, may be noted the presidential address, entitled "The Nebular Hypothesis," by Mr. W. E. Plummer; "Sun-spots and Terrestrial Magnetism," by Father Cortie, S.J. (a vice-president); and an account of a visit to the Yerkes Observatory by the Rev. R. Killip, secretary of the Society.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A SCHOOL of electricity is to be established in connection with the Harris Institute, Preston. The cost will be defrayed out of a legacy of 2000*l.* left for the purpose of advancing mechanical and electrical engineering by the late Mr. J. Billington Booth, of Preston. Of the bequest, 1000*l.* will be devoted to the electrical engineering department, which will be under the superintendence of Mr. G. E. Gittins.

FROM the calendar for the session 1903–4 of the Bristol University College we learn that, excluding medical students, there were 285 day students during the session 1902–3, and 751 evening students. The subscriptions to the sustentation fund for the same year amounted to more than six hundred pounds; a special fund of 5500*l.* has been completed, and amongst other amounts from various persons and public bodies, the Bristol Town Council has contributed five hundred pounds for fifteen free studentships.

Science announces that Prof. J. Mark Baldwin, of Princeton University, has been called to a new chair in philosophy and psychology in the Johns Hopkins University, where it is proposed to organise a university department in these subjects. Dr. E. W. Scripture, assistant professor of experimental psychology at Yale University, has resigned and is succeeded by Dr. Charles H. Judd. Dr. Scripture is spending the year at Leipzig, where he is carrying on researches on the analysis of speech by means of gramophone records, under the auspices of the Carnegie Institution.

As is customary at this time of the year, we have recently received a number of prospectuses of technical institutions, and to some of them reference has already been made in these columns. The polytechnics of London appear to try, year by year, to make their courses of study more and more attractive to practical workmen as well as increasingly useful. The workshops in them are excellently equipped, and the practical demonstrations and lectures in connection therewith should prove of great benefit in supplying workmen with a knowledge of the scientific principles upon which their particular branches of technology are based. It is gratifying to observe a tendency towards specialisation on

the part of the various polytechnics, and a growing disposition to give prominent attention to the industries in their immediate neighbourhood. Thus at the Northampton Institute in Clerkenwell there are, in addition to many other classes, a department of electrochemistry to meet the needs of the men in the numerous workshops in the district engaged in the electroplating industry, and a horological department for the large numbers employed in clock and watch making. At the Borough Polytechnic there are, besides numerous other courses of study, a special school of bakery and confectionery managed by the Association of Master Bakers and Confectioners, and a branch institution at Bermondsey is concerned with leather manufacture in all its branches. Some other polytechnics, though not perhaps specialised yet to the same extent as those mentioned, have numerous trade classes; at the Battersea Polytechnic, for example, the prospectus shows that mechanical and electrical engineers, men in the building trades, and those employed in technical applications of chemistry, can all find classes designed to meet their requirements.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 14.—M. Bouquet de la Grye in the chair.—The simplicity of the spectra of the kathode light in gaseous compounds of nitrogen and carbon, by M. H. **Deslandres**. The kathode ray spectra of carbon monoxide, carbon dioxide, and acetylene have been studied. In the luminous part already known, and in the first half of the ultra-violet region (λ 400 to λ 300), the kathode light gives nearly the same spectrum as the light from the positive pole, but in the second half of the ultra-violet (λ 300 to λ 200) it gives a characteristic spectrum, a new band spectrum in addition to the five band spectra of carbon already known, characterised by a remarkable simplicity in the arithmetical relations of the bands.—The action of a trace of water on the decomposition of the alkaline hydrides by acetylene, by M. Henri **Moissan**. Dry acetylene gas only reacts with potassium hydride at a temperature of 42° C. or higher; if the gas, however, contains a trace of water, the reaction can take place at the ordinary temperature. This is attributed to the disengagement of heat which occurs when the reaction is started at any one point, which determines a rise of temperature to more than 42°, after which the combination becomes total.—On equations of differences possessing a fundamental system of integrals, by M. Alph. **Guldberg**.—Description of a localised storm, by M. Jean **Mascart**.—On the resistance of *Gasterosteus aculeatus* to changes of osmotic pressure in the surrounding medium, by M. Michel **Siedlecki**.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physicomathematical section), part iv. for 1903, contains the following memoirs communicated to the Society:—

June 27.—Ed. **Riecke**: On the nearly-saturated current in an air-space bounded by two concentric spheres. W. **Voigt**: Contribution to the theory of light for active crystals. On specific optical properties of hemimorphous crystals. Ph. **Furtwängler**: On the construction of a certain *Klassenkörper* (domain).

July 11.—O. **Wallach**: Researches from the Göttingen University Chemical Laboratory, xii. (1) On the transformation of cyclic ketones into bases of nitrogenous ring-systems; (2) on a new cyclic base from methylheptenone; (3) on the behaviour and constitution of menthenone. J. **von Braun**: Contribution to our knowledge of tetravalent oxygen.

July 25.—Ed. **Riecke**: On nearly-saturated currents between two parallel planes.

NEW SOUTH WALES.

Linnean Society, July 29.—Dr. T. Storie Dixson, president, in the chair.—The continental origin of Fiji, by Mr. Walter G. **Woolnough**. Part ii., petrology. The rocks now described fall chronologically into two groups:—(1) a Palæozoic, or even older group, of quartzites, slates, jointed tuffs, granites and quartz-diorites; and (2) a Cainozoic group of andesites, olivine-andesites akin to basalts, "soap-stones," and molluscan and coral limestones.—The bacterial origin of the gums of the arabin group, by Dr. R. Greig **Smith**. x. The pararabin gum of Sterculia. The gum of *Sterculia diversifolia* consists of a mixture of arabin and pararabin. The arabin is produced by *Bact. acaciae*. Another organism, *Bact. pararabinum* n.sp., was isolated from the gummed fruits, &c. Upon solid media and in solutions containing saccharose, dextrose, levulose, galactose, mannite or glycerine, a slime was formed. By appropriate treatment this yielded a pararabin gum which was soluble in dilute acids and insoluble in dilute alkalies. It was not hydrolysed by boiling 5 per cent. sulphuric acid, but by treatment with concentrated sulphuric acid the carbohydrate was converted into arabinose and galactose. The bacterium did not secrete invertase, and in solutions of saccharose formed carbon dioxide, ethyl alcohol, succinic, acetic, butyric and formic acids.—Australian fungi, new or unrecorded, decades v.–vi., by Mr. D. **McAlpine**. A new genus of Hyphomycete is proposed, to include a form parasitic upon the flowering stems of *Lobelia gibbosa*, Labill.; also eighteen species, referable to thirteen genera. *Phoma lobeliae*, B. and Br., and *Seynesia banksiae*, Henn., are recorded.

CONTENTS.

THURSDAY, OCTOBER 1, 1903.

MRS. MARCET REDIVIVA.

Die Schule der Chemie. Erste Einführung in die Chemie für Iedermann. By Wilhelm Ostwald. Part i., General Considerations. Pp. vii+186. (Braunschweig: Friedrich Vieweg und Sohn, 1903.) Price 4.80 marks.

PROF. OSTWALD is an ingenious man; in his own language, the attribute might be expressed by the adjective "schlau." Having, as he tells us in his preface, published volumes of the greatest importance, and of the widest range, on physical chemistry for the use of investigators in the domains of chemistry and physics, and having next written his work on elementary chemistry for the ordinary student commencing the study of the subject in universities or Polytechnika (a work of which an excellent English translation by Dr. Findlay has been brought out), he now makes an attempt in this very elementary work to reach a larger public, and has written this most amusing book for the use of youngsters about ten to thirteen years of age. The plan adopted is to introduce by means of dialogue some chemical facts concerning hydrogen, oxygen, water, nitrogen, air, and carbon and its oxides, and incidentally to consider the nature of pure substances and mixtures, including solutions, the phenomena relating to change of state, and the behaviour of gases with alteration of pressure and temperature. All these subjects are treated in a philosophical manner, and his own views are incidentally, and one might almost say insidiously, introduced, so as to set the young mind on what he considers to be the right track.

Beginning with the notion of a "Stoff," or "stuff"—a convenient word, inasmuch as the word "Substanz," or "substance," from its derivational point of view, by no means accords with the views of the author—the properties of a stuff—sugar—are considered, and the pupil is made to reject the idea of a "substance" by subtracting properties, and recognising that there is no underlying entity. "You must rid yourself of the idea," the pupil is told, "that there is anything underlying the properties of a thing, which is more real or important than the properties themselves. Formerly, before science had progressed, people held such notions, and our language still retains expressions which almost force us to accept the notions. But when once that error is recognised, it can be avoided." To which the pupil replies that he is afraid that he will have difficulty in getting rid of the old views. "But," replies the teacher, "when you know more chemistry, you will see that you have to do only with the properties of stuffs, and never with their real nature; so that you will forget the incorrect method of expression."

Later on, in talking about the melting point of ice, the teacher defines it as "that temperature at which solid and liquid can exist beside each other"; and the pupil asks, "Then, who made this law?" The teacher answers, "The word *law* is only a way of speaking. It has been found that stuffs behave like this, and they have been compared to obedient pupils who always do what they are told. In science the word law means only that we find that things are related to each other in a certain way; and that is expressed in a general form."

In discussing change of state, the teacher refers to the term "state of aggregation," and explains it by the conception of atoms. He elucidates the word "hypothesis," but declines to accept the atomic hypothesis as an "explanation" of states of aggregation, and suggests the word "Formarten," and this leads to the consideration of differences between the states of solid, liquid, and gas. Having got the pupil to infer that liquids when cooled become solid, and solids when heated melt at definite temperatures, the pupil asks, "What determines these temperatures?" "That is a stupid question. You should rather ask: To what other properties do they show that they are related? It is just as if you were to ask: why are there camels? All that you can ask is, what are the properties of these animals, and how are these properties connected with those of other animals?"

Talking of the combustion of a candle and its disappearance, the pupil says, "But it really vanishes before my eyes." "Yes," says the teacher, "it becomes invisible. But can't it change into something invisible?" "There are no invisible things," says the pupil. "Oho!" replies the teacher. "No," says the pupil, "ghosts and goblins don't exist." "Even they are said to be sometimes visible," answers the teacher. "But can you see the air?" "Hum—no," says the pupil. "But the air is changed by burning. I don't see how." And so the formation of an invisible gas is brought out, and the method of determining its weight.

In considering heat and light produced by combustion, their absence of weight is remarked, and the pupil guesses that they are "forces." The teacher corrects, and explains that what used to be known as force is now known as energy, and that it is defined as "what causes things to change." Stuffs contain chemical energy when they can act on each other and form new stuffs, and part of their chemical energy takes the form of heat or light, and sometimes of electrical or mechanical energy. The pupil is made to throw out suggestions on the conversion of one form of energy into another, and his own energy is traced to the chemical energy he takes in as food. "But I am often hungry, even when I do nothing," says the pupil. And it is explained that his temperature has to be maintained, and that if he likes he can produce light by rubbing two pieces of sugar together, and electricity by rubbing sealing-wax with a cloth. In this way an idea is given of transformation and equivalence of energy.

Compounds and elements are next considered, and the pupil asks the natural question, "Are the constituents actually in the compound or not?" "You haven't considered your question. A compound is not a bag or a box in which something can be contained.

If you mean by 'in' that the constituents can be got out again by appropriate means, then they are 'in.' But you mustn't suppose that the constituents are locked up in the compound, somehow or other, with all their properties."

So far, it might be supposed that this system does not differ from the "heuristic" system which has been so much in evidence lately. But that is not so. There is no attempt made to prove anything exhaustively, or to let the pupil do so; as a rule, the experiment is made by the teacher, and the pupil is sometimes allowed to repeat it. A little later, in considering the classification of certain elements, the pupil remarks, "But it appears to me not very scientific to take anything on trust that I can't prove." To which the teacher answers, "You will be able to prove this, when you know more chemistry."

Teleological "explanations" are conspicuous by their absence. Yet when the pupil inquires, "Why have most chemical stuffs such a nasty smell?" he is told, "If they hadn't, we shouldn't notice them, and we should have our skin hurt and get a cold in the head." This is not quite consistent.

That the cost of an article depends on the amount of work put into it is illustrated in the case of aluminium, the compounds of which, such as clay, have almost no value, while the metal is costly. The pupil inquires, "Can the work be got out of the aluminium again?" "Yes," says the teacher, and shows the pupil the reduction of iron oxide by means of powdered aluminium.

The pupil is constantly afraid that he will not be able to retain in his head all that he is taught. But he is comforted by being assured that he will have to go over the subject again, and that he really knows a good deal. These little remarks are very natural, and the answers are most judicious. But we agree with the pupil when he says "Chemistry is a frightfully big subject!" Indeed, he is told that no one man knows all about oxygen, in reply to a remark, flattering to the teacher, "But surely you know all about this!" Much is in writing, however; and he then asks, "Is everything in these books right?" "Most of it," he is assured; and what is best about scientific books is that no one intentionally tries to deceive.

The action of iron oxide in accelerating the evolution of oxygen from potassium chlorate is likened to that of oil on a rusty machine, or of a whip on a horse. And so catalytic phenomena are introduced. There are many such digressions, and often the teacher lets them go on to a certain point, and then harks back to the actual subject of the lesson.

The pupil is introduced to the idea of mass-action after he has made the natural remark, "But iron is stronger than hydrogen, and takes the oxygen from it." "First iron was stronger than hydrogen, and afterwards, hydrogen stronger than iron. That's surely a contradiction." "The contradiction is owing to your looking at the reason of chemical changes as a mechanical power or force; such a force has never been proved to exist or measured." And when pressed, the teacher fences thus, "A man can carry a good lot of water; but a larger quantity of water can carry a man." "So you mean, chemical change depends on which stuff is present in largest quantity." "That's about it; but we must go back to hydrogen." And the digression closes.

The laws of recurrence and of continuity are illustrated and formulated; the existence of allotropic forms of carbon is referred to the difference in their content of energy, and the source of all terrestrial energy, except that of the tides, is traced to the sun, due attention being paid to the reciprocal action of plants and animals.

One admirable feature of the work is that the pupil is allowed to fall into all kinds of traps. For example, he calculates the conversion of the Fahrenheit into the centigrade scale in every conceivable wrong manner before he finds the right use of the "32"; and after he has seen experiments on the compressibility of air and the observations have been written down, he is made to find the law. The method is so good that it is worth quoting. "Suppose you have ten apples: some in your pocket, some in your hand. Call the number of apples in your pocket t, and those in your hand h. Now you know you can calculate t if you know h, and h if you know t. Why is that?" "Because I know that together they make 10." "You see then $t+h=10$; and you can calculate t if you know h, and *vice versâ*." "That's neat. But I could have done that without a formula." "Yes; but only because the formula is so simple. Now try if your pressures and volumes can be calculated as simply." "Let me see:—$75+100=175$; $62.5+120=182.5$; $60+150=210$. No; the sum is always getting bigger." "The sum formula doesn't fit, then. You might have seen that you can only add like things, such as apples to apples: you can't add a pressure to a volume." "What sort of formula can it be, then?" "If p gets bigger, v gets smaller. What kind of combination of p and v will give that result?" "Probably a whole lot." "Quite true; but not many simple combinations. Try the simplest you can think of, besides the sum." "Perhaps the product. If one factor gets smaller, the other must get larger, so as to make the same product." And so he gets it out.

It must be allowed that this is excellent teaching. The whole book is so lively and conversational, and withal so amusing, that it well deserves reading by those of an older generation. It is probably likely to be more useful to teachers than to pupils, for it will serve them as a guide. As the publishers say in their preface, the standpoint from which the book is written is the most modern one; some, perhaps, may consider it too modern, and that some of the doctrines expounded are as yet not in general circulation, and perhaps never will attain universal consent. That is a matter of opinion, and, of course, the author believes that they will. Anyhow, he has taken advantage of the lessons of all missionaries—get hold of the children, and the doctrines will spread. And if an attractive book can help their dissemination, this is one.

W. R.

EXPERIMENTAL EMBRYOLOGY.

Lehrbuch der vergleichenden Entwicklungsgeschichte der wirbellosen Thiere. By Profs. E. Korschelt and K. Heider. Allg. Theil, Erste Lief., Erste und Zweite Auflage. Pp. x+538. (Jena: Fischer, 1902.) Price 14 marks. Zweite Lief., Erste und Zweite Auflage. Pp. 539 to 750. (Jena: Fischer, 1903.) Price 5.50 marks.

ZOOLOGISTS who are already acquainted with the "special" part of Profs. Korschelt and Heider's "Comparative Embryology" will have been anxiously looking forward to the publication of the present volume; we are sure that they will in no wise be disappointed. At present we have only a first instalment, but even this contains an enormous amount of matter, including, as it does, a review of all the recent work on the physiology of development, besides a complete history of the sexual cells.

The latter portion, we may as well say at once, should have come first. Logically, the phenomena of what Roux has called "Vorentwickelung" are more closely related to descriptive than to experimental embryology; and if the order of the first and second portions had been reversed, the authors would have been able to include under a common discussion the kindred problems of ontogeny and heredity.

Of this second portion we have no space to treat at length. It must suffice to say that the student will find here an excellent *résumé* of all that is known on the structure, maturation, and fertilisation of the germ-cells. Criticism is hardly called for; but the definition of the mammalian placenta (p. 292) is out of date, and we should have liked to have seen a less fragmentary account of the maturation phenomena in plants. On the other hand, the difficult subject of maturation is treated with remarkable lucidity, while the attitude of the authors towards the vexed questions of qualitative reduction, and, in the next chapter, the individuality of the centrosome, is admirable in its judicial impartiality.

By far the most important part of the book, however, is the first section—that dealing with the work of the new school of experimental embryologists. The problems at issue are sharply defined in an introductory preface. As the authors rightly remark, ontogeny consists of a series of changes in which every stage is —in the strictest sense of the word—a cause of that which immediately follows. The business of the experimenter is to analyse the phenomena, to determine what is due to external, what to internal factors, and, in respect to the latter, how much is attributable to the initial structure visible or invisible of the ovum, how much to the mutual interaction of the parts that are successively developed.

With this object in view the ground is first cleared by a discussion of the external factors, beginning, quite rightly, not only from a logical, but from a historical point of view, with the pioneer work of Pflüger on the influence of gravity on the segmentation of the frog's egg. An account of the subsequent, and consequent, work of Born, Roux and Hertwig naturally follows. Next are described the effects of heat, light, and physical and chemical changes in the gaseous and liquid environment, and lastly, a little out of their proper place we think, the few experiments that have been made to determine the influence of electricity and magnetism, and of mechanical disturbances on the course of development.

It is a pity that the authors have not introduced at this point a critical summary of the results. It is of the first importance to decide whether these external conditions constitute a series of "specific" or merely "indifferent" causes. Hertwig's artificial production of monsters by heat and salt solutions would have made an apt text for an interesting essay on "Abhängige Differenzirung," and would have served to carry on the reader to the next chapter, "Das Determinationsproblem," in which we are taken straight to the heart of the "Streitfrage" of modern embryology.

While the restoration of the eighteenth century doctrine of preformation to a prominent place in embryological literature dates from His's theory of "Organbildende Keimbezirke," the attempt to gauge its worth experimentally begins with Roux's work on the production of half-embryos from a single blastomere of the frog's ovum. Roux's results, or rather his interpretation, were wholly in favour of this doctrine; their value has, however, been diminished by Hertwig's criticism and Herlitzka's work on the newt. The Amphibia, indeed, together with Amphioxus, the Teleostei, and the Cœlenterata, stand, so far as the "regulative" capacity of their ova are concerned, at one end of a series, at the other extreme of which are forms, the Ctenophora and Mollusca, the isolated blastomeres of which are incapable of developing into anything but partial larvæ. The intermediate position is occupied by the Echinoderms and Ascidians; here the segmentation of such blastomeres is partial, but a whole larva is ultimately formed. Any general theory, therefore, of the necessary predetermination of the parts of the organism in the cytoplasm of the ovum is out of the question. A similar criticism, based on the pressure experiments of Driesch (Echinus) and Hertwig (Rana), is applicable to the nucleus, and, of course, cuts at the root of the "Mosaik-Theorie."

The failure of the attempt to demonstrate a preformed, though invisible, structure in the ovum throws us back on epigenesis, and compels us to search for the internal causes of ontogeny in the mutual interaction of the parts as they are formed. To deduce such interaction, however, from the known functions of cells is a very different matter; but such facts as are significant for the purpose are brought together in the third chapter under the heading of "morphogenetic cellular processes."

The general discussion of the whole problem is reserved for a separate appendix. The authors display a commendable caution in reviewing the theories of Weismann, Hertwig, and Driesch. This caution, indeed, is characteristic of the whole book, and will certainly win the approbation of every embryologist who is content to say with the authors, "wir werden die Speculation nie entbehren können, aber es wird die Aufgabe sein, das ihr zu Grunde liegende Beobachtungsmaterial möglichst zu erweitern."

THE STUDY OF ECONOMICS.

The New Cambridge Curriculum in Economics. By Alfred Marshall. Pp. 34. (London: Macmillan and Co., Ltd.) Price 1s. 6d.

"IN the United States of America, in particular, and in Germany, the subjects of Economics and Political Science are commonly represented by a strong and numerous staff, and afford the main route by which large numbers of students obtain University Honours. . . . England, on the other hand, which long held undisputed leadership in Economics, has suffered in recent years from the lack of adequate provision for the study of that subject at the Universities."

From all sides evidence is forthcoming of attempts to remedy this defect. There is a widespread revival of interest in the subject-matter of economics, and a corresponding determination on the part of its teachers to seize the opportunity to place the subject on firmer and broader foundations in the schools. Development has taken place in several directions. The "monarchical" supremacy of Mill was broken up in the 'seventies by Jevons, Cliffe Leslie, Bagehot and others. In 1890, Prof. Marshall published the first edition of the first volume of his "Principles." In the last three decades of the nineteenth century economics lost much of its insularity on the one hand, and gained in human interest on the other. The work of economists in Germany, Austria, and the United States broadened the horizon and tested the conclusions of the native researcher by an appeal to a richer experience. The advent of the working-classes to political power and the influence of a cheap Press kept social questions ever prominent, and ideas of material well-being, efficiency and comfort occupied an increasing part of economic reflection. The writings of Mr. Charles Booth, Mr. Sherwell, the Rowntrees, Mrs. Bosanquet, and other investigators have recently enjoyed a wide currency in various pure and diluted forms, and have driven many to study economics in a systematic fashion. Municipal enterprise has had a similar effect. With all these writers and students the ruling motive has been the desire to lessen poverty and to improve the quality of human life. In the book before us, Prof. Marshall voices this practical aim in a significant passage:—

"The motto of Sidgwick's 'Political Economy' is: 'Things are in the saddle and ride mankind.' What had made men become economists, in three cases out of four, was the belief that in spite of our growing command over nature it is still things that are in the saddle, still the great mass of mankind that is oppressed—oppressed by things. The desire to put mankind into the saddle is the mainspring of most economic study."

But not only has there been a quickening of interest in the condition of the people at home. The sense of imperial responsibility has deepened. Schemes of federation, sentimental and economic, have filled the air. The competition of advancing rivals has made itself felt in our markets. We have been driven to ask with Sir Robert Giffen, Is the central force of the Empire, the power to hold it together, increasing as rapidly as the Empire generally? It would be fatal while widening the circumference to weaken the centre; to fix the spokes in a rottening hub. The Empire drains the home country of valuable administrative energy of which it never has too much for high social efficiency. And in business, managers of elastic minds, wide outlook, and great organising power, in command of large masses of capital are still relatively scarce.

It is unnecessary to point out how the controversy of the last few months has impressed impartial observers with the complexity of practical economic problems, and with the urgency of studying these problems in an atmosphere uncharged with the passion of parties. The people are suddenly confronted with political choices of international moment, and their instructors are too often politicians and pressmen whose hastily acquired information displays all the symptoms of indigestion. Can the universities do something to provide the nation with more capable administrators for central and municipal government, and for the diplomatic and consular services? Can they train men for the supreme positions in the industrial and commercial world? Prof. Marshall's booklet tells us that the University of Cambridge has answered in the affirmative by instituting a new honours school in economics and associated branches of political science, and it supplies us with the ideas which have guided the Senate in framing the curriculum. This is not the place to make detailed comparisons with the similar courses newly arranged in the Universities of London, Birmingham, and Victoria. Speaking broadly, the Cambridge curriculum makes its appeal to advanced students who will be called upon to decide main questions of policy in politics and industry rather than to subordinates who wish to be equipped in the technique of administration and business. It is theoretical and scientific rather than practical and professional. Only shallow thinkers will infer that, on this account, it is out of touch with reality. Prof. Marshall is under no illusion on this point. His little book is a plea for a training which, while it fits a man for his duties as a citizen, never loses sight of the practical demands made upon the employer and the civil servant in these strenuous days. Prof. Marshall himself is his own best argument, for these pages mirror the wisdom and fairness and humility and idealism of a life devoted to economic study.

T. J.

OUR BOOK SHELF.

A Treatise on Electromagnetic Phenomena and on the Compass and its Deviations Aboard Ship. Vol. ii. By Commander T. A. Lyons, U.S. Navy. Pp. vii+582. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 25s. 6d. net.

SOME forty years ago there appeared the second edition of the "Admiralty Manual for Deviations of the Compass," and as the compass is "the soul of the ship," so the teaching of that manual remains the soul of the numerous works on the subject which different maritime countries have since published, albeit that chapters on cognate subjects may have been added thereto. Naturally America has provided her quota, and this book is her latest contribution.

This second volume of the treatise, which is devoted to the "compass and deviations aboard ship," can hardly be fully mastered until after reading the first volume, but it is in a great measure complete in itself, especially to those who have already some knowledge of terrestrial magnetism. All will agree with the author of this book when he insists upon the necessity for every navigator knowing as much as possible about his compass and that magnet—his ship—which is ever in antagonism to the earth, which does its best to direct the compass to magnetic north.

Of the five parts into which this volume is divided, part ii. treats of the manufacture of the liquid compass (the only kind in use in the U.S. Navy), giving in full detail the principles of magnetism and mechanics connected with its construction and use afterwards.

In part iii. the ship is shown to be a magnet by experimental magnetic surveys of ships illustrated by diagrams. The physical representation of the theory of the deviation of the compass is fully given, but decided exception must be taken to the instructions for determining the position of the compass after the ship is launched. It is then too late, and the experienced Superintendent of Compasses and the constructors should long before have agreed upon a place for it in the ship's drawings, and afterwards worked in harmony to keep iron fittings at a proper distance.

Part iv. treats of the mathematical theory of the deviations of the compass, and here, as in other of the mathematical investigations he gives, the author gives valuable assistance to those who are not skilled mathematicians by "filling up those gaps in the sequence of the formulas that often yawn forbiddingly."

On the question of compensation of the deviations of the compass, to which part v. is devoted, we have the least satisfactory part of the book. Thus the formula for correcting the heeling error with spheres in place is very convenient in practice, but not mathematically correct. The instructions for compensating the secondary part of the quadrantal deviation known as coefficient E by spheres are incorrect. Again, the residuary quadrantal deviation, after compensation, is described as "practically constant the world over"; but this is certainly not so in the example given of the "Machias," where, between Aden and Pechili Strait, the quadrantal deviation differed nearly 3°, as might be expected where soft iron correctors are placed near the long powerful needles of the Ritchie compass. Further, the Flinders bar will not compensate any important part of the heeling error due to soft iron as here proposed.

There is much to recommend this book to the student, both as regards the mathematical treatment of the subject and for its numerous explanatory diagrams. Its weak point lies in the parts relating to the application of theory to practice, which require modernising and a careful revision. E. W. C.

Comité international des Poids et Mesures. Procès-Verbaux des Sciences. Deux. Série. Tome ii. Session de 1903. Pp. 170. (Paris: Gauthier-Villars, 1903.)

THE *Procès-Verbaux* recently issued by the Comité international des Poids et Mesures refers to their meeting at Paris in April last. The committee included Dr. W. Foerster (president), Prof. P. Blazerna (secretary), Dr. Benoit (director of the bureau), and MM. Arndsten, D'Arrillaga, de Bodola, Egoroff, Gautier, Hasselberg, and von Lang. Their proceedings mainly had reference to the work at their bureau (Pavillon de Breteuil, Sèvres, Paris) for the current year, including the consideration of the annual expenses of the committee (100,000 francs).

The committee lament the death of their distinguished colleague, Prof. A. Cornu, on April 12 last, and also of Dr. H. von Wild, September 5, 1902, an honorary member of the committee. They announce the unanimous election on the committee of M. E. Mascart, and of Dr. A. Chappuis as an honorary member. Count de Macedo (Portugal), Dr. A. Michelson (United States), and Mr. H. J. Chaney (Great Britain) were unable to attend the present meeting.

During the past year the verification of length standards at the bureau included standards for the Board of Trade, the Education Department, the National Physical Laboratory, and other authorities in England. On the application of the British Government, indeed, an important work was undertaken by the committee, that of the graduation and verification of a new linear standard of the metre and yard, a standard made of iridio-platinum, X section.

Although the scientific work of the bureau last year does not appear to have covered a wide field, it has followed important paths, as in some investigations (Appendix iii.) as to the linear expansion by heat of platinum, iron, nickel, steel, glass, and quartz, and the results reported by the committee are now probably among the most authoritative of such thermometric investigations. Dr. C. E. Guillaume also adds (Appendix i.) an essay on the theory of the alloys of steel and nickel, and M. E. Sauvage (Appendix ii.) an account of an international series of screw-threads, based on metric measure, as formulated at a congress held at Zürich in 1898–1900, a series which appears to be now adopted for engineering purposes in France.

Flora of the Island of Jersey. By L. V. Lester Garland. Pp. xv+205. (London: West, Newman and Co., 1903.)

ALTHOUGH in most parts of the country a botanist can generally make a goodly collection of plants within a day's journey of his residence, there is always a desire to visit those localities in the British Isles which have a special flora of their own. Such are the Scotch mountain ranges, the counties of Devon and Cornwall, and by no means the least interesting to the southerner, the Channel Islands. On these visits it is a great boon to have a flora which will give the information where certain plants may be sought. For Guernsey and the adjacent islands of Alderney and Sark, Mr. Marquand has published records, and no less welcome is the compact little book which Mr. Lester Garland has compiled on the flora of Jersey. The book presents one essentially new feature, since the system adopted is that of Engler. Some excuse is offered for the innovation, but there can be no question that Engler's system is bound to supplant that of the "Genera Plantarum," and considerable credit is due to the author for acting up to his convictions. In conformity with this change some of the generic names have been altered, and Erucastrum, Lobularia, and Parentucellia take the place of others more familiar; for the same reason *Tillaea muscosa*, L., becomes *Crassula Tillaea*, Lester. No trouble has been spared to test uncertain or critical species and records, and the notes on these are sound and practical; also distinction is made between native plants and aliens. The genus Centaurea serves to illustrate the author's caution and care; he declines to split up *Centaurea nigra* into uncertain varieties, queries *Centaurea scabiosa*, accepts *Centaurea scabra*, and classes the species cyanus, paniculata, calcitrapa, solstitialis among the aliens. The last few pages are devoted to an account of the geographical distribution and affinities of species, and these complete a book which, in addition to its convenient form, is to be recommended for its extremely practical and scientific value.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Radium and the Geological Age of the Earth.

AT various times since the appearance of Mr. W. E. Wilson's suggestion (NATURE, July 9) that the presence of radium in the sun might enter as an important factor in contributing to solar radiation, I had intended directing the attention of geologists to the direct application of this suggestion to the views entertained as to the extent of geological time. Absence from home led me to defer doing so.

Prof. Darwin has in a large measure anticipated my remarks (NATURE, September 24) by pointing out that the age of the sun can no longer be determined from dynamical considerations if supplies of energy from radio-active bodies go towards maintaining solar temperature. It will have to be shown, indeed, that such bodies do not enter even as a small ingredient into solar stuff (see Mr. Wilson's letter), or else that they do not retain their heat-generating properties at high temperatures. So far as experiments go—especially on the radio-active emanations—the latter contention seems improbable.

The gross dynamical supply of solar heat must no longer be regarded as affording a major limit both to solar age and geological time.

But there was one other good argument from the physical side opposed to the geological estimate of the earth's age: that derived from the observed gradient of temperature from the earth's surface inwards. Prof. Perry has pointed out (NATURE, Jan. 3, 1895) that an increase of conductivity towards the interior would lead to extension of Lord Kelvin's minor limit of time since the *Consistentior Status*. Quite equivalent to increased supplies from the interior would be a source of supply of heat in every element of the material. The establishment of the existing gradient of temperature inwards may, in fact, have been deferred indefinitely during the exhaustion of stores of radium and similar bodies at greater or shallower depths. In fact, we find these bodies here; the only question is as to how much of them exists, or at one time existed, in the earth's interior.

The remaining physical objection (that based on tidal retardation) being condemned for good reasons, it would appear that the estimates derived from physical speculations are now subject to modification in just the direction which geological data required. The hundred million years which the doctrine of uniformity requires may, in fact, yet be gladly accepted by the physicist. J. JOLY.

Trinity College, Dublin, September 26.

Some Overlooked Zoological Generic Names.

IN the course of my reading, I have found a few generic names of animals which have been overlooked in the preparation of the invaluable "Index Zoologicus," recently published by the Zoological Society of London. It may be as well to direct attention to them, so that zoologists may take note of them, and avoid duplicating them for other animals. They are:—

Callobombus, Dalla Torre, Cat. Hymenop., x. p. 503 [nom. emend.].

Cephalacanthus, Lapworth, tenth Ann. Rep. U.S. Geol. Surv., p. 641 [nom. præocc.].

Fiorentinia, Dalla Torre, Cat. Hymenop., x. p. 334.

Helenia, Walcott, *Proc.* U.S. Nat. Mus., 1889, p. 39 [not Helena, Hartm., 1881].

Holmia, Matthew, 1890 (subg. of Olenellus).

Isoxys, Walcott, tenth Ann. Rep. U.S. Geol. Surv., p. 625.

Leptomitus, Walcott, *Bull.* U.S. Geol. Surv, 1886, p. 89.

Linnarssonia, Walcott, *Amer. Journ. Sci.*, 1885, p. 114.

Olenoides, Meek, *cf. Amer. Journ. Sci.*, 1888, p. 165.

Protopharetra, Bornemann, *Geol. Zeitschr.*, 1883, p. 274.

Protocaris, Walcott, *cf. Bull.* U.S. Geol. Surv., 1886, p. 148.

Protospongia, Salter, *cf. Bull.* U.S. Geol. Surv., No. 30, p. 90. [I suppose Protospongia, Kent, 1880, is different.]

Authorities will differ as to whether Helenia should be changed because of Helena. I think it should not; the difference of a letter is enough to constitute it a distinct name. T. D. A. COCKERELL.

Colorado Springs, Colorado, U.S.A.

Height of the Atmosphere Determined from the Time of Disappearance of Blue Colour of the Sky after Sunset.

THE extreme height of our atmosphere has been determined heretofore from the observation of meteors, which begin to glow when the friction becomes sufficiently intense to vaporise the materials of which they are composed. This method is very satisfactory from most points of view, and will perhaps continue to be used by astronomers. Nevertheless, I think it worth while to direct attention to another method, which is more simple, and which, I believe, will be found equally accurate. It consists in observing with the naked eye the gradual disappearance of the *blue* colour of the sky as darkness comes on. It is surprising how accurate a person of good sight can make this observation when the atmosphere is perfectly clear. The time of sunset should be noted, and the time of the last sensible blue of the sky. With the data in the Nautical Almanac a simple computation by spherical trigonometry gives the depression of the sun at the instant the blue fades out into black, and we at once calculate the height of the illuminated particles overhead. The following are the results of some observations taken by the writer at Annapolis, Md. :—

1903.	Height.	Remarks.
August 10 ...	125 miles ...	A trace of blue remaining.
,, 21 ...	130 ,, ...	Blue just vanishing.
,, 22 ...	133 ,, ...	Sky just black.
,, 23 ...	135 ,, ...	Blue has disappeared.
,, 24 ...	132 ,, ...	Blue vanishing.

Average height, 131 miles.

The uncertainty of this value will probably be between five and ten miles.

The instant the blue disappears from the sky is a little indefinite, owing to the gradual thinning out of particles in the upper air sufficiently dense to reflect blue light which can be seen by the eye against a black night sky, but I have not found this indefiniteness so great as might be expected. It does not seem to lead to greater uncertainty in the height of the atmosphere than the method depending on meteors.

Prof. Newcomb, in his "Popular Astronomy," p. 397, says that, from observations taken at Richmond and Washington during the meteoric shower of November 13, 1867, "the general result was that they (the meteors) were first seen at an average height of 75 miles, and disappeared at a height of 55 miles. There was no positive evidence that any meteor commenced at a height greater than 100 miles. It is remarkable that this corresponds very nearly to the greatest height at which most of the brilliant meteors are ever certainly seen. These phenomena seem to indicate that our atmosphere, instead of terminating at a height of 45 miles, as was formerly supposed, really extends to a height of between 100 and 110 miles."

According to Lord Rayleigh's theory the blue colour of the sky is due to reflection of sun-light from minute particles of oxygen and nitrogen in the upper layers of our atmosphere. This theory receives its most striking confirmation from the long duration of the blue colour after sunset, showing the great height of the particles which scatter the blue light. There can, I think, be very little doubt that our atmosphere extends to a height of about 130 miles.

Washington, D.C., September 1. T. J. J. SEE.

The Lyrids of 1903.

BEING absent I did not see the letter on the Lyrids of 1903 at the time of its appearance in NATURE of July 23. The Lyrid maximum occurred this year, it would seem, on the night of April 22, or a day later than an important display observed by Mr. Denning on April 21, 1901. The night of April 22 happened to be overcast here. There was a fair amount of meteoric activity seen by the present

writer and other observers on the night of April 19, several brilliant meteors having been observed. If the computed time of the maximum for that night be correct, viz. 10h. 30m., it would not, of course, have been possible for observers situated near the longitude of Greenwich to witness the display in its entirety.

The Lyrid activity on the night of April 21, judging from Mr. Alphonso King's letter, appears to have been somewhat exceptional, and scarcely inferior to that observed on April 22 It may be interesting to note that the well-known continental observer, Prof. A. A. Nijland, states that the night of April 19, as well as that of April 20, was almost constantly and entirely overcast, and that not a single Lyrid was observed at Utrecht in 1903, though the night of April 21 was both clear and moonless. This negative result might have been anticipated from the forecast which appeared in NATURE last April. JOHN R. HENRY.

Dublin, September 21.

Glow-worm and Thunderstorm; also Milk.

IN the *Daily News* of July 14 is printed an observation by a Mr. Haswell, of Handsworth, which bears the marks of genuineness, that during a thunderstorm a glow-worm extinguished its light for a second or a second and a half before each flash, relighting at an equal interval after the flash. May I ask if this has been noticed by anyone else?

It may also be worth while for someone to examine whether radium can assist milk to turn sour, or can otherwise influence organic processes of that kind.

OLIVER LODGE.

ILL-HEALTH OF THE RAND MINERS.[1]

THE two official reports described in the footnote are not pleasant reading; it seems that the War Office is not the only culprit with regard to South African affairs, for the waste of life among the Transvaal miners from disease and accidents may fairly be described as appalling. But here, as in the case of the War Commission, the Briton is not afraid to wash his dirty linen in public, and for this he must be commended. The remedy for an ill will be discovered most speedily, if the symptoms are proclaimed widely and discussed freely.

The first document tells us that the death-rate among the natives employed at the mines on the Rand is 42 per 1000, which is extremely high. To see exactly what this figure means, we should compare it with the mortality rate of males of like age and occupation in this country; and no one can say that too favourable a case is taken if we choose, as a standard, the Cornish miner, who notoriously is a great sufferer from the ills which pertain to work below ground. Unfortunately, the official report does not state the mean age of the Rand miners, but it may be fairly assumed that the majority are young, and probably no great error would be made if their ages were taken as ranging from 25 to 35. In the years 1890–92 the mean annual death-rate of Cornish tin miners of 25 to 35 years of age was 8.06 per 1000, and for the men of 35 to 45 it rose to 14.32 per 1000. In brief, the death-rate of the natives employed at mines on the Rand is five times as much as that of the Cornish miners for the life-period 25 to 35, and nearly three times that of the men in the life-period 35 to 45.

The endeavour to cast some of the blame upon the natives themselves by saying that they fail to take ordinary common-sense precautions is ungenerous on the part of the author of the report. In matters of hygiene, the natives must be regarded as children and treated as such. The blame for the ill-health of the native must in the main lie at the door of the British employer. It is satisfactory, however, to learn that the present heavy death-rate on the Rand is regarded as exceptional.

The second document is a Blue-book containing the report of a Commission appointed by Lord Milner to inquire into the disease commonly known as miner's phthisis. Judging by the facts and figures brought forward, the inquiry has taken place none too soon. The Commissioners report "that the disease prevails to a very great extent, and that a high mortality is due to it." Carefully prepared medical evidence shows very plainly that the malady is silicosis pure and simple, a dust disease. The miner inhales sharp, angular particles of quartz, and these cause such irritation that the lung tissue undergoes a change and gradually becomes incapable of carrying on its respiratory functions. At the end of a few years, often only six or seven, so large a proportion of the lungs is rendered useless that the man dies. The age at death of many of the victims is only about 35 years. In the majority of cases there is no tubercular phthisis added to the silicosis. As might be expected, the men working rock drills are the greatest sufferers; and especially in places where the holes are bored upwards without any water.

The remedies suggested by the Commissioners are sprays and jets of water to prevent and keep down the dust, and some of the witnesses advocate the use of respirators, which are already being employed to a certain extent. The Commissioners are of opinion that experience is needed before deciding how water can be best applied.

Though dust is the worst evil affecting the miner on the Rand, it is not the only one. Analyses show undesirable proportions of carbonic oxide in what is called "normal mine air under ordinary working conditions." This noxious gas is generated mainly by the dynamite and other explosives, but also in some cases by heat acting upon the lubricant during the compression of the air used for working the drills. Mine-managers are often unaware of this latter source of danger. Mr. E. Hill, in a paper read before the American Institute of Mining Engineers, puts the matter very plainly by saying, "Workmen at the front, instead of receiving pure, cool air from the exhaust of the drills or other machines, breathe a foul, stupefying, and sometimes fatal, mixture."

The Transvaal Commissioners deserve much credit for the painstaking inquiry which they have made, and the lessons taught by it should be taken to heart by English mine-owners, for both Dr. Ogle and Dr. Tatham in their well-known reports have pointed out, that the Cornish tin miner is a great sufferer from his dust-producing occupation.

[1] "Rand Mines (Native Mortality). Return of the Statistics of Mortality, Sickness and Desertion among the Natives employed in the Rand Mines during the Period October, 1902–March, 1903." Pp. 6 folio. (London, 1903.)
"Report of the Miners' Phthisis Commission, 1902–1903, with Minutes of Proceedings and Minutes of Evidence." Pp. 147 folio and 7 appendices. (Pretoria, 1903.)

PHOTOGRAPHY AT THE NEW GALLERY.

THE forty-eighth annual exhibition of the Royal Photographic Society is, in general arrangements, much like its predecessors, and shows very little evidence of this being the jubilee year of the Society. In the scientific and technical division the only difference that we notice is the reappearance of several exhibits that have been seen before, and the presence of a few isolated frames of examples from the Society's own collection. We understood that the Society's fine historical collection was to have been on view in its entirety, and feel much regret that advantage has not been taken of this opportunity for its display.

The fact that many of the exhibits are old and already well known gives especial value to the present

collection, and that value would have been much enhanced if the scientific section had been subdivided into definite sections, and the order in the catalogue had corresponded to the order on the walls, as we have previously advocated. But the student will be well repaid for the trouble that is imposed upon him of sorting out the exhibits for himself.

Telephotography, or, as we prefer to call it, large-image photography—for the only function of a telephotographic lens is to enlarge the image before it falls upon the sensitive surface, and whether the original image is small by reason of the distance of the object or because of its size makes no difference—is better represented probably than ever before. The well known "Mont Blanc," by M. Fred. Boissonnas, is on view again, also an early telephotograph by the late Prof. W. K. Burton, of interest because of its age. But the most striking and new applications of this kind of work are shown by M. Fred. Boissonnas of enlargements of telephotographs. He gives several examples in sets of three:—(1) a photograph with an ordinary lens; (2) with a telephotographic lens; (3) an enlargement of the latter, the proportional sizes being approximately as 1 : 5 : 24. Thus a measurement of one inch on the first becomes two feet on the last, and the detail, vigour and general quality of the enlargements are surprising, and demonstrate the fine quality of the image given by the telephotographic lens.

The gradual changes that take place during rapid movement or slow development are well represented by three new series. Sixteen radiographs showing the various stages in the incubation of a pigeon's egg, by Mr. M. W. Martin, enable one to trace the process very clearly, the first appearance of blood vessels and of the beak being quite marked, and the final packing of the two parts of the shell together ready for removal from the nest by the old bird fitly completes the series. Mr. Martin also exhibits a beautifully made series of forty radiographs illustrating the evolution of the common frog, appropriately finishing with an old frog which has broken its leg. The life-history of a splash is well shown by Mr. A. C. Banfield in a series of thirty-six photographs.

Colour work is not so much in evidence as it was at the last two or three exhibitions. We have no opportunity of judging whether any appreciable advance has been effected, because in no case is the original object shown with the photograph. For this reason many of these exhibits have no value, for we do not need at the present day any proof that photographs in colour can be produced.

Photomicrography is well represented. The student will probably be specially interested in Mr. Spitta's "small garden spider," ×20, taken with a 50mm. planar, as a fine example of low-power work; the fourteen photographs of test objects, ranging up to a magnification of about 4300, also by Mr. Spitta, and Mr. Albert Norman's series of photographs of different bacilli.

We have not space to do more than mention the fact that the exhibition includes astronomical and spectroscopic photographs, as fine a series of photographs from balloons as, probably, has ever been brought together, photographs of many kinds of animals, birds, reptiles, insects, fishes, flowers, and plants; photographs in mines and quarries and dark factories, illustrations of waves and ripples and lightning, and many splendid reproductions by many different processes. The science of photography itself is represented by photomicrographs of film sections by Mr. Edgar Senior, including multiple films, and a Lippmann's colour photograph showing a very large number of layers of deposit due to the stationary waves, and Mr. Watkins's demonstrations of the validity of his time method of development.

NOTES.

THE fund established by Mrs. Elizabeth Thompson, of Stamford, Connecticut, "for the advancement and prosecution of scientific research in its broadest sense," now amounts to 26,000 dollars. As accumulated income will be available in January next, the trustees desire to receive applications for appropriations in aid of scientific work. Preference will be given to those investigations which cannot otherwise be provided for, which have for their object the advancement of human knowledge or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance. Further particulars can be obtained from the secretary of the Board of Trustees, Dr. C. S. Minot, Harvard Medical School, Boston, Mass., U.S.A. It is intended to make new grants in January, 1904. Decided preference will be given to applications for small amounts, and grants exceeding 300 dollars will be made only in very exceptional circumstances. The following list of grants for 1902 has not previously been recorded:—125 dollars to Dr. F. T. Lewis, Cambridge, Mass., for investigation of the development of the vena cava inferior; 150 dollars to Prof. Henry E. Crampton, New York, for experiments on variation and selection in Lepidoptera; 100 dollars to Prof. Frank W. Bancroft, Berkeley, Cal., for experiments on the inheritance of acquired characters; 250 dollars to Prof. John Weinzirl, Albuquerque, N.M., for investigation of the relations of climate to the cure of tuberculosis; 300 dollars to Prof. H. S. Grindley, Urbana, Ill., for the investigation of the proteids of flesh; 300 dollars to Dr. Herbert H. Field, Zürich, Switzerland, to aid the work of the Concilium Bibliographicum (an additional grant of 300 dollars was made June, 1903); 250 dollars to Dr. T. A. Jaggar, Cambridge, Mass., for experiments in dynamical geology; 50 dollars to Prof. E. O. Jordan, Chicago, Ill., for the study of the bionomics of Anopheles; 300 dollars to Dr. E. Anding, Munich, Bavaria, to assist the publication of his work, "Ueber die Bewegung der Sonne durch den Weltraum"; 300 dollars to Prof. W. P. Bradley, Middletown, Conn., for investigations on matter in the critical state; 300 dollars to Prof. Hugo Kronecker, Bern, Switzerland, for assistance in preparing his physiological researches for publication; 300 dollars to Prof. W. Valentiner, Heidelberg, Germany, for observations on variable stars.

PROF. VON BEHRING is reported to have brought before the Medical Congress at Cassel some new conceptions regarding tuberculosis. The fundamental idea of his theory is that tuberculosis in animals and in man represents different varieties of the same disease, and that it is transferable by the agency of tuberculous milk; in these respects he is in direct opposition to Prof. Koch. He distinguishes between adults and infants, maintaining that the former may as a rule safely partake of unsterilised milk, while infants are particularly liable to infection from that source, and he holds that infection may take place many years before the disease becomes manifest. Prof. Behring is now engaged in experiments upon new-born animals with the view of testing the possibility of rendering them immune against tuberculosis by supplying them with a suitable solution of tuberculous virus in the food. He is further inclined to believe that the milk of cows which have been rendered immune contains prophylactic elements which it will be practicable to employ in the treatment of the disease in human beings.

THE death is announced of M. A. Certes, formerly president of the French Zoological Society. M. Certes carried out numerous delicate researches on bacteria, and presented several memoirs to the Paris Academy of Sciences.

ON the invitation of the leading engineering societies of the United States, it has been decided that the next autumn meeting of the Iron and Steel Institute shall be held in New York on October 24–26, 1904. After the meeting there will be an excursion to Philadelphia, Washington, Pittsburg, Cleveland, Niagara Falls, and Buffalo, returning to New York on November 10. Arrangements will also be made for a visit to the St. Louis Exhibition.

THE death is announced of Mr. John Allen Brown, who was the author of numerous papers on geological and anthropological subjects, and of a volume "Palæolithic Man in North-west Middlesex."

THE trials on the electric railway between Zossen and Marienfeld, near Berlin, have been continued during the past week, and on September 26 a speed of 118 miles an hour was attained, as against 114 miles recorded last week.

IT has been decided to hold the American Conference on Tuberculosis at Washington on April 4–6, 1905, and not at St. Louis in 1904, as previously arranged. This course has been adopted so that the American meeting shall not clash with the International Congress on Tuberculosis to be held in Paris next year.

WE learn from *La Nature* that M. Dybowski, the Inspector-General of Colonial Agriculture, has just been appointed by the Minister of French Colonies to undertake a mission to Senegal and French Guinea to study the conditions existing in these possessions with a view to future enterprise in the direction of agricultural colonisation.

THE Harben lectures for 1903 will be given under the auspices of the Royal Institution of Public Health in King's College, London, by Prof. Ferdinand Hueppe, of Prague, on October 8, 12, and 15. The subjects for the respective days are:—(1) the etiology of infectious diseases from the standpoint of natural science; (2) hygienic lessons to be derived from the serum treatment; and (3) tuberculosis.

Two violent shocks of earthquake were felt on the night of September 22 at Blidah at an interval of three seconds. The total duration is estimated at fifteen seconds. The direction was from the south-east to the north-west. A slight shock lasting from four to five seconds was felt at Algiers at the same time. Two earthquake shocks also occurred in the Canaries on September 22, and caused cracks in the walls of several houses.

M. DE LA VAULX made a balloon ascent from St. Cloud, Paris, at 7 p.m. on Saturday, September 26, and reached Hull at 11 o'clock on the following morning. The balloon started with a favourable wind, and reached the Channel at 1 a.m. on September 27, crossed it in an hour and fifty minutes, and passed over the Thames at 5 a.m. almost midway between Greenwich and Chatham. As the balloon skirted the Wash four hours later it was evident that the wind was changing. From there the voyage to the Humber occupied an hour and fifty minutes. When nearing Hull it was seen that the journey could not be continued without danger of being blown out to sea, so a descent was made at 11.40 six miles north-east of Hull.

A COMMITTEE has been appointed by the Cunard Steamship Company to investigate the application of marine turbines to steamers, with special reference to the suitability of this class of engines for the two great vessels which are to be built under the agreement with His Majesty's Government. The Admiralty is represented by Engineer Rear-Admiral Oram, Deputy-Engineer-in-Chief of the Navy, and he will be assisted by Engineer Lieutenant Wood as secretary of the committee. Sir William White, late Director of Naval Construction, has also consented to give his assistance. Ordinary marine engines powerful enough to propel the projected Cunarders at 25 knots would be so excessively heavy that the comparative lightness of marine turbines would be a considerable advantage if their trustworthiness could be demonstrated. The questions of steam consumption and fuel economy of the turbines will also be investigated.

IN a letter to the *Times* (September 15), Mrs. Garrett Anderson, M.D., gives a valuable analysis of the data published in the "Report of the Metropolitan Asylums Board" respecting the 1901–2 epidemic of small-pox, in order to discuss the evidence there afforded upon (1) the protective influence of infant vaccination and the limits of its duration; (2) the necessity for systematic revaccination at school age; (3) the cost to the ratepayers of the method now employed. In the epidemic of 1901–2, 9659 persons were admitted to the small-pox hospitals, of whom 1663 died, equal to 17·1 per cent. Disregarding all doubtful cases, in 1901, 264 vaccinated persons under twenty contracted small-pox, of whom 175 were between fifteen and twenty, that is, they had reached an age when the protective power of infant vaccination is seriously weakened. In 1901 there were no deaths of vaccinated children, whereas there were 65 deaths of unvaccinated children under ten. In 1902 there were no deaths of vaccinated children, but 337 deaths of unvaccinated children under seven. Among vaccinated children up to fifteen years of age who contracted the disease, the mortality did not exceed 1·7 per cent. at different age periods, while among the unvaccinated it was not less than 32 per cent. From fifteen to thirty years of age the mortality is 4·8 and 30·4 per cent. respectively among the vaccinated and unvaccinated. Even up to thirty years of age the protective power of infant vaccination is, therefore, still an important factor, but is evidently waning, emphasising the need for revaccination. As regards the cost of the epidemic, Mrs. Anderson points out the great expense the ratepayers have been put to in order to provide hospital accommodation; she estimates that in Battersea every case cost 71*l*. 7*s*. 1*d*. There has to be added to this, of course, the economic loss to the community of the able-bodied through the sickness and death of those attacked.

WE have received from Mr. H. C. Russell No. 7 of his interesting current papers. We are glad to see that the number of these papers is increasing year by year. Up to October, 1902, 105 notices had been recovered, and for the last seven years the number of papers amounted to 703. One of the bottles referred to in the last paper had a drift of 29·2 miles a day; it was thrown overboard in the Socotra Sea on January 28, and found in the Gulf of Aden on February 9, having travelled 350 miles in twelve days. With one exception, this is the most rapid drift on record, so far as this series of observations is concerned. The pamphlet is accompanied by charts illustrating the drift of the bottles.

Symons's Meteorological Magazine for September contains an interesting summary of the British Rainfall Organisation on the occasion of the retirement of Mr. Sowerby Wallis, who has been intimately connected with the undertaking for more than thirty years. Most of our readers are probably aware that the system was commenced by the late Mr. G. J. Symons in 1859, by hunting up old rainfall records and the collection of actual observations. The first results were published for 1860, from the records of 168 stations. In ten years the number of stations reached 1500, and in 1890 3000 stations. Dr. H. R. Mill,

who has undertaken the sole management of the organisation, which is now recognised as of great national value, directs attention to the power of initiation possessed by the founder, as shown by the fact that the page of "British Rainfall" in 1860 hardly differed in arrangement from that at the present day, and states that in all essentials the work will be continued in the straight course which its founder impressed upon it.

IN the *Physical Review* for August, Mr. Edgar Buckingham describes a simple mechanical contrivance for tracing the family of curves which represent the adiabatics of a perfect gas.

VOL. iv. part ii. of the *Bibliotheca mathematica* contains an account of the life and works of the late Prof. P. G. Tait by Mr. Alexander Macfarlane, of South Bethlehem.

MR. FRANZ KERNTLER, of Budapest, has published a short article dealing with the potentials of the forces between elements carrying electric currents, according to Ampère's and allied laws. It is printed by the Pester Lloyd Gesellschaft.

IN the *Physical Review* for July and August, Messrs. E. F. Nichols and G. F. Hull describe experiments for determining the pressure due to radiation. In order to obtain results free from the effects due to the disturbing action of gases, (1) use was made of the most perfect reflecting surfaces to receive the radiation; (2) the action of a beam of constant intensity was studied in gases at different pressures; (3) the apparatus was arranged as a torsion balance, in such a way that the disturbing actions could in large measure be reversed; and (4) ballistic observations were made. It appears that the radiation pressure depends only on the intensity of radiation, and is independent of the wave-length, thus confirming the Maxwell-Bartoli theory within the probable errors of observation.

EAST AFRICAN chamæleons form the subject of an illustrated article by Mr. J. L. Monk in the September number of the *Zoologist*, to which serial Mr. W. W. Fowler contributes a note on what he believes to be an unknown warbler recently observed nesting in Oxfordshire.

IN the August number of the *Victorian Naturalist* Mr. W. Hopkins raises the question whether eels in Australia do not breed in fresh water. Among other facts, it is stated that in a swamp which had been dry for some months swarms of young eels made their appearance after the first rains.

IN the *American Naturalist* for July Dr. C. R. Eastman records a lung-fish with a cutting type of dentition from the Permian strata of Texas. Possibly the divergence from the normal form may be correlated with a change from marine to brackish water conditions, of which there are indications in the Permian; but in any case it is very remarkable in view of the singularly uniform type of dentition presented by the lung-fishes throughout their history. The new species is named *Sagenodus pertenuis*.

THE *Proceedings* of the Philadelphia Academy for June contain a description of a new species of Pleurotomaria from Japan. The shell resembles that of *P. beyrichi* in general form and characters, and if perfect would measure about 3 inches in height. To the same issue Mr. J. P. Moore contributes a long article on polychætous worms from Japan, Kamchatka, and Bering Sea, in the course of which many new forms are named and described; while in the section for July Messrs. Eigenmann and Kennedy have notes on fishes from Paraguay, accompanied by a synopsis of the American representatives of the cichlid group.

ONE of the most remarkable phenomena connected with Mont Pelée, in Martinique, is a gigantic plug of solidified lava which has been thrust up from the summit of the new cone of the volcano. This cone has been built up in the ancient crater-basin (the Étang Sec) to a height of 1600 feet or more, and it is now dominated by the ascending obelisk of lava, of which, through the courtesy of Prof. Angelo Heilprin, we are able to give a picture. The appearance of this mass of rock (as he tells us) was made known by Prof. Lacroix, and it calls to mind some of the pyramidated summits among the South American volcanoes. When first observed it must have been 1000 feet in height, and where implanted it has a thickness of some 300 to 350 feet. The plug has lost 180 feet, but when the photograph was taken (on June 13) it added 800 or 900 feet to the mountain, making the altitude more than 5000 feet. The obelisk terminates in a needle summit, a true *aiguille*. It is

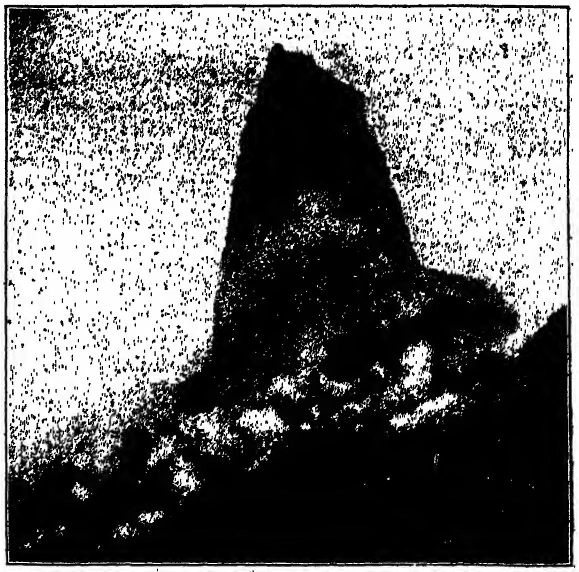


FIG. 1.—The Ascending Obelisk of Mont Pelée. Photograph by Prof. Angelo Heilprin, June 13, 1903, taken from the rim of the crater.

gently curved in the direction of St. Pierre, and on this face it is cavernous and slaggy, giving evidence that explosions have torn away portions of the lava. On the opposite side, the surface is more solid in appearance, and there it is smoothed and even polished, with grooves and striæ, like a slickensided surface—the result, evidently, of attrition when the mass was extruded. No doubt the lava was so rapidly solidified that it was unable to flow away, moving upwards, and receiving accretions to its mass from below. Prof. Heilprin observed that the growth during a period of four days measured six metres. Previously a growth of ten metres in eight days had been recorded by M. Giraud. The volcano was too active to permit of a descent into the crater-hollow; steam and sulphur-puffs were issuing, and avalanches of rock were disrupted from the obelisk. Pelée, as remarked by Prof. Heilprin (*Science*, August 7) was still "ugly."

A NEW map of the world on an equal area projection has been published by Messrs. Darbishire and Stanford, Ltd., Oxford, price 6*d*. net. British possessions are coloured red,

and the principal areas where corn, rice, and other food stuffs are at present grown are indicated by shading.

MESSRS. WATTS AND CO. have published for the Rationalist Press Association, Ltd., a carefully revised, popular edition of "Supernatural Religion. An Inquiry into the Reality of Divine Revelation." The new edition runs to 920 pages, and is issued at 6s. net.

DR. ADOLF MARCUSE, Privat-docent at the University of Berlin, having taken charge of the section of geographical surveying in the "Geographischen Jahrbuch," edited by Prof. Wagner, asks astronomers, geographers, and explorers to send him papers or other publications containing results of which notice should be taken.

AT the request of teachers of chemistry in secondary schools, Messrs. J. and A. Churchill have published separately, at 2s. 6d. net, the chapters on general chemistry contained in the "Elementary Practical Chemistry" of Dr. Clowes and Mr. J. B. Coleman. In its present form the book provides a really good course of experimental chemistry, in which the broad principles of the science are gradually presented to the student.

DR. F. BASHWORTH has prepared a pamphlet of thirty pages, published by the Cambridge University Press, containing "A Historical Sketch of the Experimental Determination of the Resistance of the Air to the Motion of Projectiles." The pamphlet gives a general survey of the author's experiments and results, which have extended over many years, and for which he devised his chronograph, and shows their relationship to other investigations.

A NEW edition of Dr. Alfred Russel Wallace's book, "The Wonderful Century. The Age of New Ideas in Science and Invention," has been published by Messrs. Swan Sonnenschein and Co., Ltd. The book has been revised and largely rewritten. Among the most important changes may be mentioned the addition of a chapter on electricity, of four chapters on astronomy, and the omission of the long chapter on the vaccination question which was included in former editions. In its new form the book provides an excellent survey of the development of science during the nineteenth century.

THIS year's issue of "Chemical Handicraft," the illustrated catalogue of chemical apparatus and reagents manufactured and sold by Messrs. John J. Griffin and Sons, Ltd., is attractively arranged and very complete. Among new apparatus we notice vessels of quartz glass scheduled on pp. 45–6. These vessels may be treated in the blowpipe flame without previous warming, and, whilst hot, be plunged into cold water without being fractured. Teachers of chemistry should find this catalogue of assistance in ordering the apparatus necessary for their laboratories and lecture-rooms.

WE have received copies of the first three *publications de circonstance* of the Conseil Permanent International pour l'Exploration de la Mer, published by MM. Høst & Fils, of Copenhagen. The first booklet is a preliminary communication, by Dr. C. G. Joh. Petersen, on how to distinguish between mature and immature plaice throughout the year; the second, by M. Martin Knudsen, deals with the standard-water used in the hydrographical research until July, 1903. The third is a larger book of 107 pages, and includes ten compendious monographs on the literature of the ten principal food fishes of the North Sea, illustrated by ten plates, and preceded by a useful index.

THE Tuesday evening popular science lectures at the Royal Victoria Hall, Waterloo Bridge Road, have been the means of creating scientific interest and activity among many people who have attended them. Many men of science have given their services as lecturers at the hall, and have helped to make known the work that is being carried on there. An appeal is now being made for subscriptions to assist the committee to meet the expenditure of 3000*l.* for alterations which had to be undertaken in order to make the building fireproof to the satisfaction of the London County Council. Donations should be sent to Miss Emma Cons, honorary secretary, Royal Victoria Hall, London, S.E.

THE additions to the Zoological Society's Gardens during the past week include two Sacred Baboons (*Papio hamadryas*), two Variegated Jackals (*Canis variegatus*), two Spotted Hyænas (*Hyaena crocuta*), a Striped Hyæna (*Hyaena striata*), a Lion (*Felis leo*), a Leopard (*Felis pardus*), an Abyssinian Duiker (*Cephalophus abyssinicus*), three Somali Ostriches (*Struthio molybdophanes*) from Somaliland, presented by Mr. William Northrup McMillan; a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mr. A. G. Turner; two Pig-tailed Monkeys (*Macacus nemestrinus*) from Java, presented by Mr. Eussens; an Otter (*Lutra vulgaris*), British, presented by Miss Boughey; two Gold-fronted Finches (*Metoponia pusilla*) from India, presented by Mr. H. C. Harper; two Black Salamanders (*Salamandra atra*) from Switzerland, presented by Mr. W. C. Worsdell; three Indian Chevrotains (*Tragulus meminna*), nine Starred Tortoises (*Testudo elegans*) from India, a Mayotte Lemur (*Lemur mayottensis*), a Fringed Gecko (*Uroplates fimbriatus*), six Green Geckos (*Phelsuma madagascariensis*), twelve Blackish Sternotheres (*Sternothoerus nigricans*), a Sharp-nosed Snake (*Lioheterodon madagascariensis*) from Madagascar, four Angulated Tortoises (*Chersina angulata*) from South Africa, fourteen Stink-pot Terrapins (*Cinosternum odoratum*), two Prickly Trionyx (*Trionyx spinifer*) from North America, a Spiny-tailed Mastigure (*Uromastix acanthinurus*) from North Africa, three Cuban Snakes (*Liophis andrae*) from Cuba, a Merrem's Snake (*Rhadinoea merremi*) from Brazil, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN OCTOBER:—

Oct. 5. 13h. 48m. to 17h. 0m. Transit of Jupiter's Sat. III. (Ganymede).

6. Partial eclipse of the moon.
   5h. 32m. Moon rises obscured by the penumbra.
   6h. 7m. Last contact with the penumbra.

10. 8h. 18m. to 9h. 11m. Moon occults α Tauri (Aldebaran, Mag. 1·1).

15. Venus. Illuminated portion of disc=0·188, of Mars =0·907.

18. 9h. 41m. Minimum of Algol (β Persei).

" 15h. 0m. Mercury at greatest elongation (18° 13′ W.).

" 19h. 0m. Mercury in conjunction with moon, Mercury 1° 57′ N.

19–22. Epoch of Orionid meteoric shower. (Radiant 91°+15°).

21. 6h. 30m. Minimum of Algol (β Persei).

22. Saturn. Polar diameter =15″·7. Minor axis outer ring=13″·62.

24. 3h. Mars in conjunction with Uranus, Mars 1° 13′ S.

" 12h. Venus at greatest brilliancy.

31. 7h. Jupiter in conjunction with moon, Jupiter 3° 39′ S.

REPORT OF THE PARIS OBSERVATORY FOR 1902.—In his report of the Paris Observatory for 1902, M. M. Lœwy, the director, describes in detail the various important series of observations made at that observatory.

In announcing that the last two volumes of the "Catalogue de l'Observatoire de Paris" are ready for publication, M. Lœwy gives a detailed account of the circumstances which led to the inception and prosecution of the work necessary for the publication of such a complete stellar catalogue.

For the determination of the latitude of the Paris Observatory, 6530 measures of the absolute polar distances of fundamental stars were made with the large meridian circle during the year, and, in accordance with Sir David Gill's proposals, 5063 observations of reference stars for the astrographic chart were made.

The observations for the redetermination of the difference of longitude between Paris and Greenwich were completed, and the concordance between the observations of the Paris and Greenwich observers in the first series, which has been completely reduced, is very striking.

504 photographs of the moon for the "Atlas Photographique de la Lune," of which the sixth section has been published, were taken with the large equatorial coudé. A 6-inch grating, for use with the smaller equatorial coudé, has been ordered from America, and when this is received it is proposed to carry out, systematically, similar researches in solar physics to those which are already prosecuted in England and America.

In connection with the "International Astrographic Chart and Catalogue" fifty-six plates for the chart and twelve for the catalogue were secured; the printing of the catalogue for zone +24° was completed, and it contains the positions of 64,264 stars, whilst the publication of zone +23° was commenced and the section 0h. 4m. to 6h. 20m. completed. Altogether the positions of 21,855 stars were completely measured for the catalogue, and the magnitudes of 35,630 stars belonging to zone +23° were determined during 1902.

THE RIGIDITY OF PIERS FOR MERIDIAN CIRCLES.—In No. 3902 of the *Astronomische Nachrichten*, Prof. G. W. Hough, of the Dearborn Observatory (U.S.A.), discusses in detail the relative merits of brick and stone piers as supports for meridian circles. It will perhaps be remembered that in the last report of the superintendent of the United States Naval Observatory it was stated that since the substitution of a brick pier for the marble pier that was formerly used, the previously reported changes in azimuth of the 6-inch Repsold meridian circle had entirely disappeared. The experience of Prof. Hough is opposed to the principle contained in that statement, viz. that brick piers are superior to stone for this purpose.

By a table of comparative expansions he shows that those of granite, sandstone, &c., approximate more nearly than that of brick to the expansion of iron, and therefore, with iron fastenings, a stone pier will ensure a greater rigidity of the instrument in regard to the pier; from the same table it is seen that brass fastenings are far more likely to produce lack of rigidity than those made of iron.

RECENT PAPERS ON METEORITES.

THROUGH the courtesy of Prof. Henry A. Ward, of Rochester, New York, we are able to reproduce for our readers a photograph which gives a good idea of the form and dimensions of the large mass of meteoric iron lying at a place called Ranchito, near Bacubirito, in the province of Sinaloa, Mexico. The existence of the mass was made known to the scientific world by Prof. Barcena more than a quarter of a century ago, and, later, its dimensions were recorded by Prof. Castillo; but until after the visit of Prof. Ward there had been no published information as to the particulars of the occurrence. Prof. Ward, who is greatly interested in meteorites, travelled from the city of Mexico to Bacubirito, an extremely long, arduous, and expensive journey, for the special purpose of examining the meteorite *in situ*. It was found by him to be lying at the place specified, but to have only one end projecting from the ground. Twenty-eight labourers were employed by him to excavate round the mass and make it possible to determine the complete form. After two days' work not only had this been done but, through removal of the support from one side, the large mass had been made to turn itself over. It is 13 feet 1 inch long, 6 feet 2 inches wide, and 5 feet 4 inches thick. Its irregularity of form and the character of the surface are manifest from Fig. 1. The mass is estimated to weigh

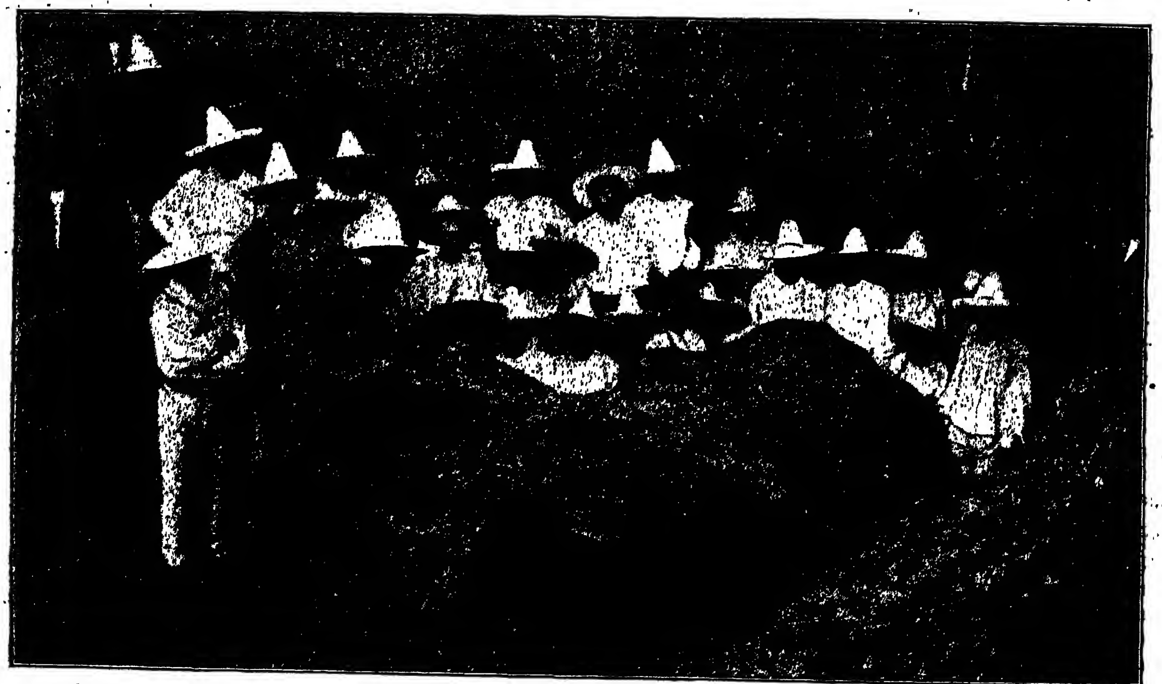


FIG. 1.—The Meteoric Iron of Bacubirito, Sinaloa, Mexico.

50 tons (the specific gravity having been determined to be 7·69), and it is probably at least as large as the big mass brought some years ago from Greenland to the United States by Lieutenant Peary. After these two, the next largest known meteorite in the world is that of Chupaderos, which has lately been removed to the city of Mexico and found to weigh 15¾ tons. A polished face of the Bacubirito iron, when etched, shows very distinct Widmänstätten figures. According to a chemical analysis made by Prof. Whitfield the percentage of nickel (and cobalt) is 7·2. The time of fall of the mass is unknown. The meteorite is described by Prof. Ward in the *Proceedings* of the Rochester Academy of Science (vol. iv. p. 67, 1902).

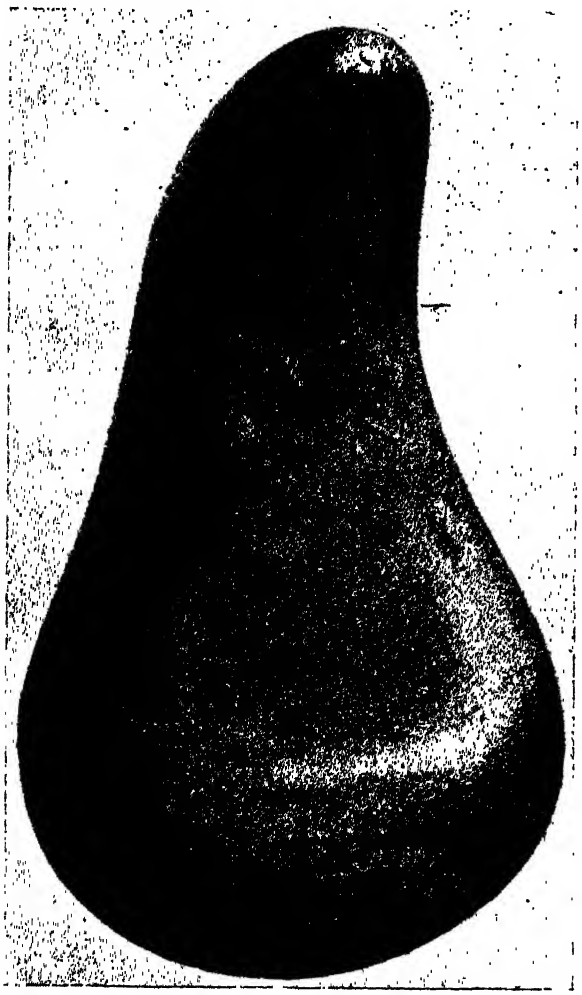


FIG. 2.—The Boogaldi meteorite, N.S.W. Showing "drip" from the underside, tail end. Length 5 inches, width 3 inches; weight 2057·5 grms. Sp. gr. 7·85.

In the *Journal* and *Proceedings* of the Royal Society of New South Wales, vol. xxxvi. pp. 341–359, Prof. Archibald Liversidge, F.R.S., of Sydney, gives descriptions of four meteorites, all from New South Wales, one of them a meteoric iron, the other three meteoric stones. The meteoric iron, though not actually observed to fall, was found shortly after that event; it was noticed in January, 1900, that the ground had been torn up on a hard ridge near Boogaldi Post Office; the furrow was followed, and a small pear-shaped mass of iron was found slightly embedded in the ground; it had come from the north-west, and its path must have been inclined at only a small angle to the horizon. It weighed 4½ lb., and has a specific gravity of 7·8. The surface is formed by a skin of fused oxide, which has been arranged in waves with transverse furrows by the motion through the air (Fig. 3); part of the fused oxide has accumulated at the thin end of the meteorite, and part of it has doubtless been blown off at that part (Fig. 2). A polished section, when etched, shows well-marked Widmanstätten figures; only one or two specks of troilite are visible on the etched face. Chemical analysis of the metallic sawdust obtained on cutting the meteorite shows that the nickel and cobalt amount to 8·5 per cent. In addition to the chemical elements normally present in meteorites, Prof. Liversidge found small quantities of arsenic, gold, and either platinum or some other member of the platinum group.

The places of fall of the meteoric stones were (1) Barratta, near Deniliquin; (2) Gilgoin, near Brewarrina; (3) Eli Elwah, near Hay; the falls were not actually observed. The stones are all remarkable for their size. In the case of Barratta, about 2 cwt. had been found on a previous

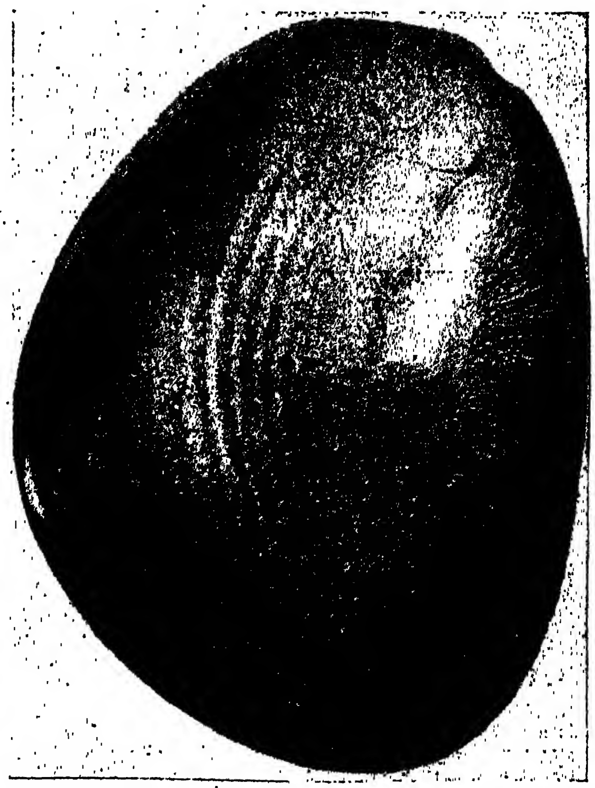


FIG. 3.—The Boogaldi meteorite, N.S.W. Showing waves formed in the fluid skin at the forward end; the right hand side was the lower one during flight. Enlarged two diameters.

occasion many years ago; two other stones have lately been found weighing 31½ lb. and 48 lb. respectively. The Gilgoin stones weigh 67½ lb. and 74½ lb., and the Eli Elwah stone 35½ lb. All these stones have a chondritic structure; the specific gravities range from 3·39 to 3·86. The paper is illustrated with no fewer than twelve plates.

In the *Publications* of the Field Columbian Museum (Geological Series, vol. i. pp. 283–315) Dr. O. C. Farrington gives an account of various meteorites. The first of them is from Long Island, Phillips County, Kansas, of the structure of which Dr. Weinschenk gave a minute description several years ago. The meteorite, which belongs to the chondritic kind, was not observed to fall, and must have been in the ground some time before it was found. Fragments having a total weight of 1244 lb. have been recovered; it is therefore the largest meteoric stone which has yet been met with. The larger fragments can be closely fitted together, and the original form of the mass is thus reproduced. The directive character of the pittings and furrows is very suggestive of the exterior of the Goalpara stone,

Chemically, the meteorite is remarkable for its high percentage (6·3) of chromium sesquioxide. Dr. Farrington suggests that a small portion may be present as a constituent of the olivine, and the rest as part of the chromite. The author next enters into a discussion of the relations of the various meteoric stones which have been found in Ness County and other parts of north-western Kansas; he infers that Prairie Dog Creek, Long Island, Oakley, Jerome, and Franklinville belong to distinct falls, and that Wellmanville may be part of the Franklinville fall, and Kansada part of either the Franklinville or the Jerome meteorite. Another meteorite described is one from Los Reyes, forty miles from Toluca; this is an iron, and its characters are similar to those of other masses found nearer Toluca; there is no reason to believe that the mass has been transported by man from the latter locality. The Los Reyes mass may belong either to a distinct fall or indicate a wide spreading of the Toluca shower. In the same paper an account is given of the structure of the meteoric iron found in the Hopewell Mounds of Ohio; one of these is a small, unwrought mass weighing about five ounces, the others are worked specimens, namely, a part of a head and ear ornament, some celts, and a number of beads; they were all found associated with a single human skeleton near an altar of one of the mounds; the iron, when etched, shows Widmanstätten figures, which have been bent and distorted by hammering. Finally, Dr. Farrington states that the tænite extracted from the Kenton County meteorite was found on analysis to consist of 80·3 parts of iron and 19·7 parts of nickel (and cobalt).

THE BRITISH ASSOCIATION.

SECTION F.

ECONOMIC SCIENCE AND STATISTICS.

OPENING ADDRESS BY EDWARD W. BRABROOK, C.B., F.S.A., V.P.S.S., PRESIDENT OF THE SECTION.

IT is a coincidence, which has great interest for me personally, that the honour of being President of this Section has fallen to me in the last year of my engagement in the public service. I am now in the sixty-fifth year of my age and the thirty-fifth of my connection with the Registry of Friendly Societies, and in a few months the guillotine of the Order in Council will fall, and the Department and its present head will be severed. The consequences are not so tragic as they sound, for the Department will at once find a new head, and the old head will contrive to maintain a separate existence. I therefore meet the stroke of fate with cheerfulness; for I am strongly of opinion that the arrangements for retirement from the Civil Service of the country are as wise as they are liberal. It is a good thing that the place of a man whose ideas have grown old and become fixed, and whose long service indisposes him to entertain new ones, should be taken by a younger man anxious to make his own mark on the administration of his department. Again, the prospect of promotion opened up by the limited term of service of the older men is a distinct inducement to able and ambitious young men to devote themselves to their country's service. I have lately had occasion to give minute and careful attention to one branch of this important question, and the study of the whole subject which has thus been rendered necessary has strongly confirmed the conviction I previously entertained that the system of retirement which now prevails greatly tends to promote the efficiency of the Civil Service and the interests of the country. I do not apologise for saying this much on a subject into which I was led by an observation that concerns me personally, for the means of securing efficiency in the public service is an important economic question.

The coincidence to which I refer tempts me to choose as the principal subject of the Address which I am permitted and enjoined to deliver to the Section on this occasion that small corner of the great field of Economics in which I have been a day labourer for so long, and I am not able to resist the temptation. My piece of allotment ground, if I may so call it, is that which is devoted to the cultivation of thrift, or of economy in the popular rather than the scientific sense. The temptation is strengthened by the circumstance that that subject has rarely been treated by my predecessors. Sir Robert Giffen in his Address of 1887 referred to it, and Sir Charles Fremantle in 1892 treated it at somewhat greater length. In old times, when the Chair of this Section was more frequently occupied by the practical statesman than by the professed economist, there were passing allusions to it by Henry Fawcett in 1872, William Edward Forster in 1873, and Sir Richard Temple in 1884; but in more recent years the accomplished economists who have presided over this Section, notably my immediate predecessor, have delivered luminous and memorable Addresses on the broad principles of Economics, the application and potency of its doctrines, and their serviceableness to mankind, with a comprehensiveness of view that is only attainable as the result of deep study, and a brilliancy of exposition that belongs to philosophic insight. I may here, in passing, express the satisfaction we all feel that at Cambridge, where we are to meet next year, proficiency in Economics and Political Science is now fully recognised as qualifying for academical honours.

I have spoken of the subject of Thrift as a small corner of the great field of Economics; and relatively to the broad field itself it is so; but it is a subject that deals with large figures and intimately affects large numbers of people. The 2000 Building Societies in Great Britain and Ireland have 600,000 members and sixty-two millions of funds; the 28,000 bodies registered under the Friendly Societies Act have 12,000,000 members and forty-three millions of funds; the 2000 co-operative societies have 2,000,000 members and forty millions of funds; the 600 trade unions have more than a million and a half members and nearly five millions of funds; in the 13,000 Post Office and other savings banks there are more than 10,000,000 depositors and more than 200 millions invested; so that upon the whole in nearly 50,000 thrift organisations with which the Registry of Friendly Societies has, in one form or other, to deal there are twenty-seven millions of persons interested and 360 millions of money engaged. These figures, however, possess no significance other than that they are very big. Many individuals are necessarily counted more than once, as belonging to more than one society in one class, or to more than one class of societies. Some portion of the funds of Friendly Societies is invested in savings banks, and therefore is counted twice over. Some of the co-operative societies, as, for example, the wholesale societies, have for capital the contributions of other societies, which thus are also counted twice over. On the other hand, the aggregate, large as it is, is necessarily defective. It includes only bodies which are brought into relation with the Registry of Friendly Societies in one or other of the functions exercised by that department. It does not include, therefore, many co-operative and other bodies which are registered under the Companies Act, nor the Industrial Assurance Companies which are regulated by the Assurance Companies Act, nor does it include the great body of Friendly Societies which are not registered at all. Among these shop clubs hold a prominent position, and these are very numerous. The Royal Commissioners of thirty years ago thought that the unregistered were then commensurate with the registered bodies; and as one result of the legislation which the Commissioners recommended has been to diminish the applications for registry made by such societies as are subjected by it to the necessity of a periodical valuation of assets and liabilities, there seems no reason to think that unregistered societies are relatively now any fewer than they were then.

It would seem, then, that the figures we have cited are well within the mark, and that, used for the mere purpose of indicating the magnitude of the interests involved, they may be relied upon as not over-estimating it. The observation just made leads to the question, why should there be so many unregistered societies? Why, indeed, should there be any unregistered societies? The National Conference of Friendly Societies, which consists wholly of registered bodies, has just passed a resolution recommending the enactment of a law that all societies should be compelled to register. Why not? I think it will not be difficult to find the real answer to these questions. It was given as long ago as 1825 by a Committee of the House of Commons in these wise words:—"It is only in consideration of advantages conferred by law that any restrictive interference can be justified with voluntary associations established for lawful

and innocent purposes. It is for the individuals themselves to determine whether to adopt the provisions of the statute, which offers them at the same time regulation and privilege, or to remain perfectly unfettered by anything but their own will, and the common or more ancient law against fraud or embezzlement," which common or more ancient law was strengthened in 1868 by the Act known as Russell Gurney's Act. "For your Committee apprehend that although the Act of 1793 appears to begin by rendering lawful the institution of Friendly Societies, there neither was at that time nor is now any law or statute which deprives the King's subjects of the right of associating themselves for mutual support."

Upon this principle the Legislature has hitherto proceeded. Registration is voluntary. The subscriptions of the members are voluntary. The conditions of membership are such as the rules framed by the members themselves impose. They have full authority to alter those rules from time to time. Those conditions may, if the members so please, imply that the subscriptions are to be small and the benefits large. They may provide for investment of funds on any security they think fit so long as it is not personal security. They may provide for the periodical division of the funds so long as they make it clear that all claims existing at the time of division are first to be met. Up to this point the registered society and the unregistered are hardly distinguishable. What, then, are the obligations consequent upon registry? There is the making an annual return and the making a quinquennial valuation; but the action to be taken by the society upon the result of the valuation is wholly in the discretion of the members. The valuer may demonstrate beyond doubt that the society in order to save itself from disaster must increase the subscriptions of the members or diminish their benefits; but neither he nor the Registrar can enforce the recommendation. The society has its destinies wholly in its own hands. Then, again, the Act contains certain provisions for the protection of members. Individual members have the right to inspect the books of the society, to receive copies of its balance sheets and valuations, and so forth. A certain number of the members have the right to apply to the Registrar to appoint an inspector into the affairs of the society or to call a special meeting of the members. The inspector can only report—there is no action which the Registrar can take upon his report if the members disregard it. The special meeting will in no way differ from an ordinary meeting called by the society itself, except that it may choose its own chairman. The Registrar cannot in any way control its proceedings. Even these things he cannot do of his own motion without being set in action by a competent number of the members. If a society becomes insolvent, members may in like manner apply to him to wind it up: he may see that a readjustment of contributions and benefits would set the society on its legs again, and may suspend his award of dissolution to enable the society to make that readjustment, but he can do no more. If the society refuse to make it, he has no option but at the end of the period of suspension to issue the award. Here again he may have the fullest knowledge that a society is hopelessly insolvent, yet he can do nothing unless a competent number of the members call in his aid. I confess that I think the Legislature might have gone further in this respect and conferred upon the Registrar, or at any rate upon some public authority, the power to deal compulsorily with cases of hopeless insolvency, and if necessary to appoint a receiver, as such cases are not infrequently complicated with fraud carried on in circumstances which make it difficult for a competent number of the members to join in an application to the Registrar. However that may be, taking the legislation as it stands, it embodies to the fullest extent the principle laid down by the Committee of 1825.

The surrender of freedom which a Friendly Society is called upon to make in order to obtain the privileges of registry, which are not inconsiderable, is therefore exceedingly small; yet it is sufficient, as we have seen, to keep out of the registry office a large number of societies. It seems not improbable, looking back on the history of legislation on the subject—and the observation is a curious one—that unwillingness to register has been closely connected with actuarial considerations. Thus, in the year 1819, an Act was passed which provided, among other things, that the justices should not confirm any tables or rules connected with calculation until they had been approved by two persons at least known to be professional actuaries or persons skilled in calculation; but that was repealed in 1829. Again, in 1846 an Act was passed which provided, among other things, that every registered society should make a quinquennial valuation; but that was repealed in 1850 before a single quinquennial period had arrived. It was not until a quarter of a century after 1850 that this most salutary provision again found a place in the statute book, and the experience of the last twenty-eight years has shown how valuable it is, and how much it is to be regretted that the Act of 1846 was not allowed to remain in force. Again, the Act of 1850 provided for the discrimination of societies into two classes: those which were simply registered and those which were certified. These latter were to obtain the certificate of a qualified actuary that their tables of contribution were sufficient for the benefits they proposed to insure. Very few certified societies were established, and that Act was repealed in 1855. The experience of the Legislature has not been favourable therefore to endeavours to impose upon Friendly Societies by Act of Parliament conditions of actuarial soundness.

If, however, the voluntary principle is abandoned, and all societies are to be compelled to register, it is obvious that there must be a recurrence to the policy of imposing such conditions. At present a registered society may be as unsound as it pleases, and so may an unregistered society. Unless registry is to imply something more than that, there can be no reason for any compulsion to register. For what does compulsion mean? It means prosecuting, fining, and sending to prison all persons who associate themselves together for the lawful and innocent purpose of mutual support in sickness and adversity without registration; and that, obviously, cannot reasonably be done unless abstinence from registration is shown to be a moral offence; that is to say, unless the conditions of registration are such that a registered society shall be necessarily a good one, and an unregistered society necessarily a bad one. We must begin, at any rate, by devising model tables and insisting that every society shall adopt them. Are they not ready to hand? Did not my lamented colleague, Mr. Sutton, prepare a Blue Book of 1350 pages full of them? That is true; but it is also true that in the brief introductory remarks which he addressed to me at the beginning of that report he observed, with great force, that the adoption of sufficient rates of contribution is not enough to secure the soundness of a society. Those rates are derived from the average experience of all classes of societies—some exercising careful supervision over claims for sick pay, others lax in their management—and it is upon care in the management, rather than upon sufficiency of rates, that the success of a Friendly Society mainly depends. If the members administer the affairs of their society with the same rigorous parsimony and watch over the claims for sick-pay with the same vigilance which a poor and prudent man is compelled to exercise in the administration of his own household affairs, the society will be more than solvent, even though they do not pay as high a contribution as the model tables exact. If they neglect these precautions, there is no model table which will rescue them from ultimate insolvency. In Mr. Sutton's happy phrase, it is the personal equation of the members and of their medical adviser that tells the most on the prosperity or the failure of a society. Your compulsory registration will impose unfair conditions on the well-managed societies, and will do nothing to prevent the inevitable collapse of those which are badly managed. Registration tells for a great deal while it is voluntary and free; but if you make it compulsory, and add to it conditions that you suppose will tend to soundness, you will inevitably do more harm than good. It is, of course, of vital importance that adequate rates of contribution should be charged for the benefits proposed to be ensured; but if these are imposed by authority, the management of the societies must also be undertaken by the same authority. It is a curious observation, which has been borne out by experience, that in poor societies the claims for sickness are relatively less than in rich ones. M. Bertillon, the eminent French statistician, has shrewdly remarked: "The truth is, that friendly societies, when they grant sick-pay, attach less weight to the text of their rules than to the state of their funds. If the society is rich, it grants relief

more freely than if it is poor. Thence, and thence only, it comes that the great English societies, which are often very old and generally rich, give more days' pay than the French societies, for example, which are bound to a rigorous economy." Without necessarily assenting to all that M. Bertillon says, it is easy to see that if the State were unwise enough to say that such-and-such rates would be sufficient, it would encourage laxity of management, and accept a responsibility that does not belong to it.

I may now proceed to show that the present voluntary system, unscientific as it may be supposed to be, works very well on the whole. Its most useful feature is the valuation, for a society which disregards the lessons of one valuation finds itself pulled up sharply by the results of a second. A deficiency that is frankly faced by an increase of contributions, a reduction of benefits, or a levy, or by all three together, will probably not only disappear, but be succeeded by a surplus; but a deficiency that is disregarded not only grows at compound interest, but increases by the continued operation of the causes which produced it. It is to be remembered that a valuation deficiency or surplus, as the case may be, in a Friendly Society is always hypothetical. It means this in the case of deficiency—if you go on as you are going and do not modify your contracts you will ultimately be in a deficiency of which this is the present value. In the case of surplus it means—if you go on as you are going and do not allow your prosperity to tempt you to recklessness you will probably have enough to meet all your engagements, and this much over together with its improvements at interest.

When Friendly Societies are considered in their economic aspect, they appear to be an excellent application of the principle of insurance to the wants of the industrial community. Sickness may come upon a working man at any time, and may disable him from work for an indefinite period. In such an event, if he had nothing to rely upon but his own savings accumulated while he was at work, they would before long be exhausted, and he would be left in distress. By combining with a number of others who are exposed to the same risk, he can fall back upon the contributions to the common fund which have been made by those who have escaped sickness. It is an essential part of every contract of insurance that the contributions of all who are exposed to an equal contingent risk are equal; but the benefits are only derivable by those of the number in whose experience the contingent risk becomes actual, and they receive more than they have paid, the deficiency being made up out of the contributions of those who have escaped the contingent risk.

This really seems too elementary a proposition to be worth stating, but it is the fact that the principle of insurance is so little understood that many members of Friendly Societies look upon themselves as having performed an altruistic and charitable act in joining a society when they have been fortunate enough not to make claims upon it through sickness. Several intelligent witnesses before Lord Rothschild's Committee on Old-age Pensions, representing large and well-managed societies, actually urged upon the Committee that the members of Friendly Societies were more deserving of old-age pensions than other people because they subscribed for the benefit of others and not of themselves.

Another economic point of view in which Friendly Societies call for consideration is that of their relation to the Poor Law. The old Act of 1793, which was the day of elaborate preambles to statutes, affirmed that the protection and encouragement of such societies would be likely to be attended with very beneficial effects by promoting the happiness of individuals, and at the same time diminishing the public burthens. The public burthen at which this was pointed was no doubt the Poor Law, which was then administered in a very different manner from that which has prevailed since the great reform of 1834, and one of the items of encouragement which the Legislature provided for the societies was that their members should not be liable to removal under the Poor Law until they had actually become chargeable to their respective parishes. This exemption was no doubt of great value at that time, when the law of settlement bore very severely upon the poor.

It appears to me that the proper relation of the Friendly Societies to the Poor Law is a negative one. The main object of the societies should be, as indeed it is, to keep their members independent of the Poor Law. They have done so with great success. The returns which have more than once been presented to Parliament of persons receiving relief who are or have been members of Friendly Societies have frequently been shown to be untrustworthy. The number of actual members of such societies who seek relief is small absolutely, and still smaller relatively to the population. It was therefore not without regret that I observed the passing of an Act in 1894 which empowered Boards of Guardians to grant relief out of the poor rates to members of Friendly Societies, and if they thought fit to exclude from consideration of the amount of relief to be granted the amount received by the applicant from his Friendly Society. That Act has just been followed in the natural course of events by a bill for taking away from the Guardians their discretion in the matter, and requiring them to grant full relief to the applicant in addition to the weekly sum, not exceeding five shillings, which he receives from his Friendly Society. In other words, they are to provide a pauper who is a member of a Friendly Society with a free income of five shillings a week more than they would grant as adequate relief to a pauper who was not a member of a Friendly Society, however deserving in other respects that pauper might be. Poor-law relief, instead of being a painful and deplorable necessity, is elevated into a reward of merit in the one case, in which that merit has been displayed by joining a society. A kind of old-age pension is provided for the member, but instead of being an old-age pension without the taint of pauperism, it is a condition of obtaining it that the man must become a pauper. This seems to me to be topsy-turvy legislation. The very bodies the aim and proud boast of which it should be that their members never are paupers have been contented to claim for their members the rank of privileged paupers.

The discussion of the subject of old-age pensions which has now been proceeding for the last twelve or thirteen years has had one good effect in bringing under the consideration of the Friendly Societies the practical methods by which they can obtain these pensions for themselves. The impression that some day and somehow the State would provide pensions for everybody, or at least for everybody who is thrifty, has had a bad effect; but the wiser members of the societies have seen that it would be a good thing to substitute for their present plan of continuing sick-pay to the end of life a plan of insuring a certain annuity after a given age. For this purpose they have had to overcome a natural reluctance on the part of the members to lock up their savings in the purchase of deferred annuities, and they have done so with some success, several thousands of persons having agreed to subscribe for these benefits. It is anticipated that the report of Mr. Alfred Watson on his investigations into the sickness experience of the Manchester Unity of Oddfellows will add force to this movement by showing how great a burden old-age sickness at present is, and how slight an additional sacrifice would secure a deferred annuity. It need hardly be said that it is more desirable that the members generally should do this for themselves than that they should get the State to do it for them.

Registered Friendly Societies are becoming more popular and more wealthy under the present system. The number of returns from societies and branches increased from 23,998 on December 31, 1891, to 26,431 on December 31, 1899, and 27,005 on December 31, 1901; the number of members from 4,203,601 to 5,217,261 in eight years, and to 5,479,882 in ten years; the amount of funds from 22,695,039*l*., or 5*l*. 8*s*. per member, to 32,751,869*l*., or 6*l*. 5*s*. 6*d*. per member, after eight years, and 35,572,740*l*., or 6*l*. 9*s*. 9*d*. per member, after ten years. It is necessary to observe, however, that some of the numerical increase is due to greater completeness in the later returns. The increase in ratio is not affected by this. It may be worth noting that, on the average, the proportion of members under fifty years of age to those above that age is as 81 to 19; and that of the total aggregate receipts per annum, 73 per cent. goes in benefits, 11 per cent. in management, and 16 per cent. is added to capital. The average annual contribution per member is 1*l*. 1*s*. 6*d*.

Up to this point I have referred merely to the Friendly Society of the ordinary type, the sick club and burial fund. Societies of the collecting group, while registered under the

Friendly Societies Act, are also regulated by a separate Act, and it is convenient therefore to consider them apart. They insure burial money only. They are only 46 in number, having increased from 43 in 1891. They have as many as 6,678,005 members, an increase from 5,922,615 in 1899 and 3,875,215 in 1891; but among these each individual above the age of one year in every family is counted separately, and the majority, therefore, are young children. Their funds are 5,973,104*l*., or 17*s*. 11*d*. per member, having increased from 5,207,686*l*., or 17*s*. 7*d*. per member, since 1899, and from 2,713,214*l*., or 14*s*. per member, since 1891. These societies therefore show progress like the others.

The collecting societies do a similar business to that of the Industrial Assurance Companies, of which the Prudential is the type. Their ostensible reason for existence is to answer that instinct of human nature which makes even the poorest desire that the burial of the dead should be attended with some degree of ceremony; but strong as that instinct may be, it does not prompt the poor to seek out the office of the society and pay their premiums there. They have to be solicited by canvassers and waited upon by an army of collectors at their own homes; and the maintenance of this army and the general cost of management absorb nearly half the contributions, so that the poor insurer pays double the net price for his insurance. There is reason to believe, moreover, that these societies are largely used for speculative insurances by persons who have no real insurable interest in the lives insured. So long ago as 1774 an Act was passed for the purpose of checking this sort of gambling in human life; but as it only makes the policy void, the insurer takes the risk of the society repudiating the contract, knowing that its doing so would discredit it and spoil its business.

A number of other classes of societies are capable of being registered under the Friendly Societies Act, such as cattle insurance societies, benevolent societies, working men's clubs, and societies for any purpose the registry of which the Treasury may specially authorise. The formation of cattle insurance societies on a large scale was contemplated by an Act of 1866, when the cattle plague was at its height; but in practice only small pig clubs and similar societies in Lincolnshire and the neighbouring counties have been registered under this head. Benevolent societies are defined as societies for any benevolent or charitable purpose, and might therefore comprise all the charitable institutions of the United Kingdom, but in fact the registered benevolent societies are few. Working men's clubs—frequently called working men's clubs and institutes—were first brought under the operation of the Friendly Societies Act of that day by Sir George Grey as Secretary of State in 1864, and were then societies for purposes of social intercourse, mutual helpfulness, mental and moral improvement, and rational recreation. They are still so defined by law; what they are in fact has been revealed by the provisions of the Licensing Act, 1902, as to the registration of clubs. Rules have been submitted to the Registry Office, and we have been advised that we have no discretion to refuse to register them as rules for carrying out the excellent purposes just defined, providing for the supply of intoxicating liquors to members and their friends at hours when the ordinary licensed houses are compulsorily closed, for keeping the club open every night until midnight, and on nights when there are balls until six o'clock in the morning, and for other incitements to intemperance. I hope that it will not be long before an enactment is passed that the registry of a club under the Licensing Act shall vacate its registry under the Friendly Societies Act. Such clubs have nothing to do with thrift or with insurance; they are rather instruments of extravagance, improvidence, and dissipation.

Some of the specially authorised purposes are also wide of the mark, which upon the *ejusdem generis* rule should, I think, be pointed with strictness in the direction of provident insurance; but there has always been a desire liberally to extend the benefits of the Friendly Societies Act with a view to the encouragement of societies having praiseworthy objects which for want of means or some other reason are not registered as companies. The large majority of specially authorised societies are Loan Societies, and though these may in some cases be fairly good investments for those who lend, they are of doubtful benefit to those who borrow. An exception must be made to this statement with respect to the Agricultural Credit Societies, many of which have been established in Ireland by the exertions of Sir Horace Plunkett, and have been pecuniarily assisted by the Congested Districts Board. It is a feature of these societies that they not only lend money to the small farmer, but see that he spends it on improvements to his farm; and also that there is no division of profit among the members.

The returns from all societies under the Friendly Societies Act other than Friendly Societies proper increased from 557 in 1891 to 1308 in 1899, and 1449 in 1901; the number of members from 241,446 in 1891 to 610,254 in 1899, and 649,491 in 1901; and the amount of funds from 594,808*l*. in 1891 to 1,528,064*l*. in 1899, and 1,686,656*l*. in 1901. Here, again, great allowance has to be made for the want of completeness in the returns of the earliest date.

Allied to Friendly Societies, but having special regulations under other Acts, are shop clubs and workmen's compensation schemes. In a vast number of large industrial establishments the men have their own sick club, sometimes assisted by the employer; and in a few the employer makes it a condition of employment that every workman shall join the club. Where this is done it is now enacted, not only that the club shall comply with the requirements of the Friendly Societies Act as to registry, but also with other conditions of more stringency. As yet only a few clubs have been able to satisfy all the requirements of the Shop Clubs Act, 1902. The workmen's compensation schemes provide an alternative to the general scheme of compensation to injured workmen contained in the Act of 1897, and have enabled the employers and workmen in several large industries to enter into mutual arrangements by which the workman gains an equivalent to the compensation which the Act would give him, and enters into partnership with the employer for obtaining other benefits. According to the returns, these schemes have hitherto resulted very favourably to the workmen, and it seems a pity there are not more of them.

The sentiment of which I have spoken, that it is desirable to extend the benefits of the Friendly Societies Acts to societies for good objects, even though those objects may not be purposes of provident insurance, is expressed in the statute of 1834, which allowed of "any purpose which is not illegal," and in that of 1846, in which the definition of a Friendly Society was made to include the frugal investment of the savings of the members for better enabling them to purchase food, firing, clothes, or other necessaries, or the tools, implements, or materials of their trade or calling, or to provide for the education of their children or kindred. Under these Acts the Rochdale Equitable Pioneers and a number of other Co-operative Societies were registered, and in 1852 an Act was passed specially dealing with these bodies under the name of Industrial and Provident Societies. They were made corporate bodies by an Act of 1862, and are now regulated by the Industrial and Provident Societies Act, 1893. The societies that may be registered under that Act are societies for carrying on any industries, businesses, or trades specified in or authorised by their rules, whether wholesale or retail, and including dealings of any description with land.

This definition indicates pretty clearly the manner in which Co-operative Societies have worked out their own evolution. The expression "Industries" denotes the productive form of society, a form which has always embodied the ideal of co-operation when the combined labour of the members should be engaged in the production of commodities. The expression "Businesses" indicates the recognition of the Legislature that Co-operative Societies ought to cover a wider range than was allowed by the words "labour, trade, or handicraft" in the Act of 1876, and includes banking, assurance, and the like. The expression "Trades" denotes the distributive form of society, a form in which co-operation has gained its greatest successes. The permission to carry on these functions "wholesale" as well as retail points to the system of super-association, or co-operation between societies, which has attained phenomenal proportions in the co-operative wholesale societies of Manchester and of Glasgow, and exists in a smaller degree of development in other societies. The authorising of "dealings of any description with land" relates not merely to a considerable number of land societies, but is also an indication of the great extent to which societies for other purposes have applied their profits and

some of their capital to the excellent work of providing homes for their members. It is also to be observed that many societies are both distributive and productive.

What have these societies done for their members? They have reduced the price of the necessaries of life and have thus enabled persons of limited means to enjoy some of its luxuries; they have provided a remunerative investment for small savings; they have done much to put an end to the practice of giving and taking long credit; they have done as much as in them lies to ensure the purity of commodities; they have discountenanced (though, perhaps, not with all the success that might have been hoped for) the practice of taking commissions and commercial bribery generally; they have raised the standard of comfort and have helped many members to obtain the coveted possession of a house of their own; they have devoted a share of their profits to educational purposes with excellent results. Some of the productive societies, by the practice of giving a bonus to labour, have improved the economic position of the workman and contributed to the efficiency of his work. On the other hand, co-operative societies generally have not been so successful as was expected in realising some of the aspirations of the founders of co-operation; commercial failure has not been unknown among them; losses have occurred, though the simple organisation of the societies has made it easy to deal with them by adjustments of the capital account; they have not always had the best of managers, and have sometimes failed to give their confidence where it was deserved, and given it where it was not. In many places they have had to contend with opposition from the traders to whose business and profits their success was unfavourable. Taking all things into consideration, the progress they have made is surprising.

Comparing the returns for the United Kingdom for the years ending December 31, 1891, and December 31, 1901, the increase in number of societies was from 1597 to 2175; in number of members from 1,136,907 to 1,929,628; in amount of funds from 16,545,138*l*. to 40,824,660*l*.

It has been observed that the Co-operative Societies are largely undertaking the work of providing houses for their members; and to that it may be added that the Friendly Societies are more and more tending to adopt the practice of lending money to members on mortgage as one of the most remunerative forms of investment open to them. The Building Societies, which were established for that purpose only, are still carrying on the same work, and the combined operation of all three ought to produce a material effect on the prosperity and well-being of the industrial population. Building Societies alone advance as much as 9,000,000*l*. a year on mortgage.

Building Societies have passed through a crisis. The incorporated societies reached their highest point of prosperity in 1887, when their capital amounted to fifty-four millions; by 1894 it had fallen to below forty-three millions. The Building Societies Act, 1894, required of societies a fuller disclosure of the real state of their affairs than had previously been called for. The result was to show that, apart from the special scandal caused by the fraudulent proceedings of the Liberator Society, there were hitherto undisclosed elements of weakness in the management of Building Societies that justified the withdrawal of the public confidence that had been reposed in them. The properties in possession before the passing of the Act of 1894 were not less than 7,500,000*l*.; they are now less than 3,000,000*l*. This points to the fact that the early prosperity of Building Societies had led to the establishment of more societies than the public demand called for, with the consequences that societies competed against each other, and that in the stress of competition and the anxiety to do business they accepted unsatisfactory securities, which must lead to loss upon realisation. From this point of view the effect of the Act of 1894 has been wholly salutary. Year after year the societies have reduced their properties in possession. The evils which they dreaded from the disclosure of the facts have not arisen. At this day it may be said that the societies as a whole have regained the position they held in public confidence, for the members now know the worst. They know, too, that where the blight of properties in possession still infests the business the managers are resolutely endeavouring to diminish its effect.

I need hardly repeat what has so often been said of the economic value of a sound Building Society. The man who by its means gets a stake in the country mounts many steps on the social ladder. When he has paid off the mortgage on his own dwelling-house, and so liberated himself from the obligation to pay principal and interest, either in the form of repayment annuity or of rent, what is to prevent him from buying in the same manner, as an investment, another house with the income thus set free, and so on?

There are still sixty-eight Building Societies which remain under the operation of the Act of 1836, having been established before 1856, and not having availed themselves of the option of taking upon themselves the responsibilities and the privileges of the Acts of 1874 and subsequent years. One society (the Birkbeck) stands by itself, as, although its business as a Building Society is considerable—the new advances granted on mortgage last year having been for 120,000*l*.—its main operations are those of a deposit bank, and it keeps the far greater part of its funds in investments on liquid securities. The other societies are pursuing the even tenor of their way, just as they have done for the last fifty years, and show on the average an increase of business from year to year. But the great body of Building Societies are those which are incorporated under the Acts of 1874 to 1894, exceeding 2000 in number. They have so far recovered from the effects of the depression that their assets are now forty-eight millions, being midway between the low-water mark of 1894 and the high-water mark of 1887. That and the fact that they have in about seven years reduced their properties in possession by about 60 per cent. leads to the inference that they are now, speaking generally, in a fairly healthy condition, and that many years of usefulness are still to be expected for them.

The Friendly Societies Registry also registers and receives returns from trade unions. These useful and necessary bodies have, I think, been rather cruelly treated, not only in past days, but also in more recent times. Without going back to the bad old times when six poor agricultural labourers were sentenced to seven years' transportation for forming a trade union, or even to the time when they were refused the protection of the law for the funds they had accumulated, because, forsooth, they were for an illegal purpose, it will be sufficient to mark the unexpected change that has been worked in their position since the Act of 1871 purported to render them legal. Registry under that Act authorised the trustees of a trade union to hold land not exceeding one acre, vested the property of the union in them, authorised them to sue and be sued on behalf of the union, limited their liability, made the treasurers and officers accountable to them or to the members, and enabled them to take summary proceedings against any person misapplying their funds. But it did not create the unions corporate bodies, and did not enable any Court to entertain legal proceedings for enforcing their contracts with their members, recovering contributions due from a member, or recovering from the union benefits due to a member or other person, or for enforcing any agreement between one trade union and another, even where any such contracts or agreements were secured by bond. It was commonly thought that the effect of all this would be that the unions, having none of the privileges of incorporation, would escape the liabilities which affect corporate bodies; and so much was this the general opinion that the Duke of Devonshire and other members of the Royal Commission on Labour made a minority report in which they suggested that the law in this respect should be altered.

It has recently been determined that, although unions are not corporate bodies, they are responsible for the acts of their agents as much as if they were. I do not presume to question the propriety of this decision as a matter of law, nor even to say that it is a decision which is contrary to equity; but only to point out that its result upon the individual member of a trade union, who gave no mandate to its agents to do any illegal or injurious act, but handed over his savings to the trustees of the union, relying on the stringency of the provisions of the Act as to misapplication of funds, is very serious and was unexpected. The contributions of workmen to their trade union represent an amount of self-sacrifice and self-denial that is not readily gauged or measured or understood by persons in easier circumstances of life. Their object, which is primarily to provide the sinews of war in any conflict that may be necessary to secure their material welfare, and secondarily to provide sick and funeral and pension and out-of-work

benefits against the ordinary ills of life, is one that ought to appeal most strongly to the sympathies of the economist. If it is the fact that trade unions make mistakes, as most people do, those mistakes will be much fewer and less mischievous when full legislative recognition and protection are afforded them than they were under the old *régime* of suspicion and repression.

Loan Societies under the Act of 1840 are societies for lending sums of money not exceeding 15*l.* to the industrious classes upon terms of a deduction of interest at the time of granting the loan and a corresponding weekly repayment fixed to commence at such a time that the rate of interest earned by the society shall be about 12 per cent. per annum; another instance of the experience which always faces the poor man that he has to pay for any small accommodation he wants a higher relative price than the man has who wants more. These societies are of two types: the Friends of Labour Loan Societies, existing mainly in the metropolis, having two classes of members, investing and borrowing, but limiting the subscriptions of the one class to the 15*l.*, which is the statutory limit of the loans to the other class; and what may be called the proprietary loan societies, existing mainly in Yorkshire, making their loans to non-members, and consisting of a small number of persons who contribute the whole of the capital, the holding of each proprietor sometimes amounting to several hundreds of pounds.

The Registry of Friendly Societies has for one of its functions that of granting to societies which are exclusively for purposes of science, literature, and the fine arts certificates exempting them from local rating. Though there can be no question that these certificates are of great value to many excellent institutions, such as public libraries, picture galleries, museums, and scientific and learned societies, which would find the liability to pay rates, in these days when rates have increased and are increasing so largely, a serious deduction from the scanty means at their command for maintaining their useful operations, yet I have very grave doubts whether on economic grounds any such exemption from rates is capable of being defended. The benevolent people who subscribe to maintain these buildings for the public good increase the burden upon the small ratepayer to the extent to which they fail to contribute their share. The Act of 1843 has more than once been scheduled in Bills for repealing exemptions from rating, but those Bills have not been passed, and the Act is still in force.

There only remains to consider the case of Savings Banks, which are brought in connection with the Registry of Friendly Societies by the Acts which confer upon that office exclusive and final jurisdiction in the settlement of disputes, and effectually oust the jurisdiction of the Courts of Law. Under these Acts many thousands of disputes have been settled by my predecessors, my colleagues, and myself, and at the present time an average of three appointments every week during the busy time of the year has to be made to hear the parties. We see much of the seamy side of life in these cases—many family and other quarrels of a sordid character are brought to light—and it has been noted as a curious fact that persons guilty of fraud or embezzlement seem frequently, but most unwisely, to select the Savings Bank as the securest receptacle for their ill-gotten gains. On the other hand many pathetic and touching instances of thrift and self-sacrifice have been brought under our notice, and much evidence has been accumulated as to the great value to the poor of these excellent institutions. As compared with the several self-governing bodies to which I have already directed attention, the Savings Bank may not unfairly be described as the elementary form of organisation for thrift. The depositor entrusts his money to it for mere safe custody and accumulation, and has no voice in the application of it or control over its managers. All he asks is that he may run no risk of losing it. Savings Banks are of three classes: the 230 Trustee Savings Banks of the old type which still remain, and have to their credit an undiminished amount of funds, though there were at one time more than twice as many banks; the Post Office Savings Bank, which is one of the many monuments still extant to the financial genius of Mr. Gladstone, and not less to the administrative skill of the public servants who settled the lines upon which it works, and which has increased the savings of the people more than threefold by bringing almost to every man's door the opportunity of making deposits. I hope that it may meet in its new and splendid home at West Kensington with a continuance and increase of the marvellous success which has hitherto attended it. Thirdly, there are the Railway Savings Banks, which have collected from the workmen employed and from their families nearly five million pounds. It is right to observe that they give a rate of interest exceeding by about 1 per cent. that given by the Trustee and Post Office Savings Banks. It is also to be borne in mind that the deposits in Savings Banks are not drawn wholly from the industrial population, but that many, especially women and children, belonging to other classes make use of the banks. Indeed, the Postmaster-General, in an approximate estimate made some years ago, calculated that women and children constituted 56·per cent. of the whole number of depositors. School Savings Banks and Penny Savings Banks are also to be mentioned as feeders of the ordinary Savings Banks, and as greatly increasing the opportunities of saving afforded to the young, and instilling into them valuable lessons of thrift.

Such is the story the department I am about to leave has to tell of the free and spontaneous efforts of the industrial population to better their condition by means of thrift and economy. It is, I venture to think, one which speaks well for the general body of that population and has great promise for the future of the country. In times of depression, as well as in times of prosperity, the gradual increase of the funds of these various bodies has been maintained; the members have not been compelled by the one, nor tempted by the other, to relax their efforts and their sacrifices.

I ask forgiveness for having detained you so long on so small a branch of the great subjects with which this Section has to deal, and which will be well illustrated in the important papers and discussions that are set down on its programme. The course of events has given to one group of subjects, that has often been considered in this Section, a new and unexpected prominence; and we await with keen interest the teaching which economic science has to offer on the questions of the day.

SECTION H.

ANTHROPOLOGY.

Opening Address by Prof. Johnson Symington, M.D., F.R.S., F.R.S.E., President of the Section.

It is now nearly twenty years since Anthropology attained to the dignity of being awarded a special and independent Section in this Association, and I believe it is generally admitted that during this period the valuable nature of many of the contributions, the vigour of the discussions, and the large attendance of members have amply justified the establishment and continued existence of this Section.

While the multifarious and diverse nature of the subjects which are grouped under the term Anthropology gives a variety and a breadth to our proceedings, which are very refreshing in this age of minute specialism, I feel that it adds very considerably to the difficulty of selecting a subject for a Presidential Address which will prove of general interest.

A survey of the recent advances in our knowledge of the many important questions which come within the scope of this Section would cover too wide a field for the time at my disposal, while a critical examination of the various problems that still await solution might expose me to the temptation of pronouncing opinions on subjects regarding which I could not speak with any real knowledge or experience. To avoid such risks I have decided to limit my remarks to a subject which comes within the range of my own special studies, and to invite your attention to a consideration of some problems arising from the variations in the development of the skull and the brain.

Since the institution of this Section the development, growth, and racial peculiarities of both skull and brain, and the relation of these two organs to each other, have attracted an ever-increasing amount of attention. The introduction of new and improved methods for the study of the structure of the brain and the activity of an able

band of experimenters have revolutionised our knowledge of the anatomy and physiology of the higher nerve centres.

The value of the results thus obtained is greatly enhanced by the consciousness that they bear the promise of still greater advances in the near future. If the results obtained by the craniologist have been less marked, this arises mainly from the nature of the subject, and is certainly not due to any lack of energy on their part. Our craniological collections are continually increasing, and the various prehistoric skull-caps from the Neanderthal to the Trinil still form the basis of interesting and valuable memoirs.

While the additions to our general knowledge of cerebral anatomy and physiology have been so striking, those aspects of these subjects which are of special anthropological interest have made comparatively slight progress, and cannot compare in extent and importance with the advantages based upon a study of fossil and recent crania. These facts admit of a ready explanation. Brains of anthropological interest are usually difficult to procure and to keep, and require the use of special and complicated methods for their satisfactory examination, while skulls of the leading races of mankind are readily collected, preserved, and studied. Hence it follows that the crania in our anthropological collections are as numerous, well preserved, and varied as the brains are few in number and defective, both in their state of preservation and representative character. It may reasonably be anticipated that improved methods of preservation and the growing recognition on the part of anthropologists, museum curators, and collectors of the importance of a study of the brain itself will to some extent at least remedy these defects; but so far as prehistoric man is concerned, we can never hope to have any direct evidence of the condition of his higher nerve centres, and must depend for an estimate of his cerebral development upon those more or less perfect skulls which fortunately have resisted for so many ages the corroding hand of time.

I presume we will all admit that the main value of a good collection of human skulls depends upon the light which they can be made to throw upon the relative development of the brains of different races. Such collections possess few, if any, brains taken from these or corresponding skulls, and we are thus dependent upon the study of the skulls alone for an estimate of brain development.

Vigorous attacks have not unfrequently been made upon the craniometric systems at present in general use, and the elaborate tables, compiled with so much trouble, giving the circumference, diameters, and corresponding indices of various parts of the skull, are held to afford but little information as to the real nature of skull variations, however useful they may be for purposes of classification. While by no means prepared to express entire agreement with these critics, I must admit that craniologists as a whole have concentrated their attention mainly on the external contour of the skull, and have paid comparatively little attention to the form of the cranial cavity. The outer surface of the cranium presents features which are due to other factors than brain development, and an examination of the cranial cavity not only gives us important information as to brain form, but by affording a comparison between the external and internal surfaces of the cranial wall it gives a valuable clue to the real significance of the external configuration. Beyond determining its capacity we can do but little towards an exact investigation of the cranial cavity without making a section of the skull. Forty years ago Prof. Huxley, in his work "On the Evidence of Man's Place in Nature," showed the importance of a comparison of the basal with the vaulted portion of the skull, and maintained that until it should become "an opprobrium to an ethnological collection to possess a single skull which is not bisected longitudinally" there would be "no safe basis for that ethnological craniology which aspires to give the anatomical characters of the crania of the different races of mankind." Prof. Cleland and Sir William Turner have also insisted upon this method of examination, and only two years ago Prof. D. J. Cunningham, in his Presidential Address to this Section, quoted, with approval, the forcible language of Huxley. The curators of craniological collections appear, however, to possess an invincible objection to any such treatment of the specimens under their care. Even in the Hunterian Museum in London, where Huxley himself worked at this subject, among several thousands of skulls, scarcely any have been bisected longitudinally, or had the cranial cavity exposed by a section in any other direction. The method advocated so strongly by Huxley is not only essential to a thorough study of the relations of basi-cranial axis to the vault of the cranium and to the facial portion of the skull, but also permits of casts being taken of the cranial cavity; a procedure which, I would venture to suggest, has been too much neglected by craniologists.

Every student of anatomy is familiar with the finger-like depressions on the inner surface of the cranial wall, which are described as the impress of the cerebral convolutions; but their exact distribution and the degree to which they are developed according to age, sex, race, &c., still remain to be definitely determined. Indeed, there appears to be a considerable difference of opinion as to the degree of approximation of the outer surface of the brain to the inner surface of the cranial wall. Thus the brain is frequently described as lying upon a water-bed, or as swimming in the cerebro-spinal fluid, while Hyrtle speaks of this fluid as a "ligamentum suspensorium" for the brain. Such descriptions are misleading when applied to the relation of the cerebral convolutions to the skull. There are, it is true, certain parts of the brain which are surrounded and separated from the skull by a considerable amount of fluid. These, however, are mainly the lower portions, such as the medulla oblongata and pons Varolii, which may be regarded as prolongations of the spinal cord into the cranial cavity. As they contain the centres controlling the action of the circulatory and respiratory organs, they are the most vital parts of the central nervous system, and hence need special protection. They are not, however, concerned with the regulation of complicated voluntary movements, the reception and storage of sensory impressions from lower centres, and the activity of the various mental processes. These functions we must associate with the higher parts of the brain, and especially with the convolutions of the cerebral hemispheres.

If a cast be taken of the cranial cavity and compared with the brain which had previously been carefully hardened *in situ* before removal, it will be found that the cast not only corresponds in its general form to that of the brain, but shows a considerable number of the cerebral fissures and convolutions. This moulding of the inner surface of the skull to the adjacent portions of the cerebral hemispheres is usually much more marked at the base and sides than over the vault. Since the specific gravity of the brain tissue is higher than that of the cerebro-spinal fluid, the cerebrum tends to sink towards the base and the fluid to accumulate over the vault; hence probably these differences admit of a simple mechanical explanation. Except under abnormal conditions, the amount of cerebro-spinal fluid between the skull and the cerebral convolutions is so small that from a cast of the cranial cavity we can obtain not only a good picture of the general shape and size of the higher parts of the brain, but also various details as to the convolutionary pattern. This method has been applied with marked success to the determination of the characters of the brain in various fossil lemurs by Dr. Forsyth Major and Prof. R. Burckhardt, and Prof. Gustav Schwalbe has made a large series of such casts from his craniological collection in Strassburg. The interesting observations by Schwalbe[1] on the arrangement of the "impressiones digitatæ" and "juga cerebralia," and their relation to the cerebral convolutions in man, the apes, and various other mammals, have directed special attention to a very interesting field of inquiry. As is well known, the marked prominence at the base of the human skull, separating the anterior from the middle fossa, fits into the deep cleft between the frontal and temporal lobes of the brain, and Schwalbe has shown that this ridge is continued—of course in a much less marked form—along the inner surface of the lateral wall of the skull, so that a cast of the cranial cavity presents a shallow but easily recognised groove corresponding to the portion of the Sylvian fissure of the brain separating the frontal and parietal lobes from the temporal lobe. Further, there is a distinct depression for the lodgment of the inferior frontal convolution, and a cast of the middle cranial fossa shows the three external temporal convolutions.

We must now turn to the consideration of the relations

1 "Ueber die Beziehungen zwischen Innenform und Aussenform des Schädels," *Deutsches Archiv für klinische Medicin*, 1902.

of the outer surface of the cranium to its inner surface and to the brain. This question has engaged the attention of experts as well as the "man in the street" since the time of Gall and Spurzheim, and one might naturally suppose that the last word had been said on the subject. This, however, is far from being the case. All anatomists are agreed that the essential function of the cranium is to form a box for the support and protection of the brain, and it is generally conceded that during the processes of development and growth the form of the cranium is modified in response to the stimulus transmitted to it by the brain. In fact it is brain growth that determines the form of the cranium, and not the skull that moulds the brain into shape. This belief, however, need not be accepted without some reservations. Even the brain may be conceived as being influenced by its immediate environment. There are probably periods of development when the form of the brain is modified by the resistance offered by its coverings, and there are certainly stages when the brain does not fully occupy the cranial cavity.

At an early period in the phylogeny of the vertebrate skull the structure of the greater part of the cranial wall changes from membranous tissue into cartilage, the portion persisting as membrane being situated near the median dorsal line. In the higher vertebrates the rapid and early expansion of the dorsal part of the fore-brain is so marked that the cartilaginous growth fails to keep pace with it, and more and more of the dorsal wall of the cranium remains membranous, and subsequently ossifies to form membrane bones. Cartilage, though constituting a firmer support to the brain than membrane, does not possess the same capacity of rapid growth and expansion. The head of a young child is relatively large, and its skull is distinguished from that of an adult by the small size of the cartilaginous base of the cranium as compared with the membranous vault. The appearance of top-heaviness in the young skull is gradually obliterated as age advances by the cartilage continuing slowly to grow after the vault has practically ceased to enlarge. These changes in the shape of the cranium are associated with corresponding alterations in that of the brain, and it appears to me that we have here an illustration of how the conditions of skull growth may modify the general form of the brain.

Whatever may be the precise influences that determine skull and brain growth, there can be no doubt but that within certain limits the external form of the cranium serves as a trustworthy guide to the shape of the brain. Statements such as those by Dr. J. Deniker ("The Races of Man," p. 53) "that the inequalities of the external table of the cranial walls have no relation whatever with the irregularities of the inner table, and still less have anything in common with the configuration of the various parts of the brain," are of too general and sweeping a character. Indeed, various observers have drawn attention to the fact that in certain regions the outer surface of the skull possesses elevations and depressions which closely correspond to definite fissures and convolutions of the brain. Many years ago Sir William Turner, who was a pioneer in cranio-cerebral topography, found that the prominence on the outer surface of the parietal bone, known to anatomists as the parietal eminence, was situated directly superficial to a convolution of the parietal lobe of the brain, which he consequently very appropriately named "the convolution of the parietal eminence." Quite recently Prof. G. Schwalbe has shown that the position of the third or inferior frontal convolution is indicated by a prominence on the surface of the cranium in the anterior part of the temple. This area of the brain is of special interest to all students of cerebral anatomy and physiology, since it was the discovery by the illustrious French anthropologist and physician, M. Broca, that the left inferior frontal convolution was the centre for speech, that laid the scientific foundation of our present knowledge of localisation of function in the cerebral cortex. This convolution is well known to be much more highly developed in man than in the anthropoid apes, and the presence of a human cranial speech-bump is usually easily demonstrated. The faculty of speech, however, is such a complicated cerebral function that I would warn the "new" phrenologist to be cautious in estimating the loquacity of his friends by the degree of prominence of this part of the skull, more particularly as there are other and more trustworthy methods of observation by which he can estimate this capacity.

In addition to the prominences on the outer surface of the cranium, corresponding to the convolutions of the parietal eminence and the left inferior frontal convolution, the majority of skulls possess a shallow groove marking the position of the Sylvian point and the course of the horizontal limb of the Sylvian fissure. Below these two other shallow oblique grooves indicate the line of the cerebral fissures which divide the outer surface of the temporal lobe into its three convolutions, termed superior, middle, and inferior. Most of these cranial surface markings are partially obscured in the living body by the temporal muscle, but they are of interest as showing that in certain places there is a close correspondence in form between the external surface of the brain and that of the skull. There are, however, distinct limitations in the degree to which the various cerebral fissures and convolutions impress the inner surface of the cranial wall, or are represented by inequalities on its outer aspect. Thus over the vault of the cranium the position of the fissure of Rolando and the shape of the cerebral convolutions in the so-called motor area, which lie in relation to this fissure, cannot usually be detected from a cast of the cranial cavity, and are not indicated by depressions or elevations on the surface of the skull, so that the surgeons in planning the seats of operations necessary to expose the various motor centres have to rely mainly upon certain linear and angular measurements made from points frequently remote from these centres.

The cranium is not merely a box developed for the support and protection of the brain, and more or less accurately moulded in conformity with the growth of this organ. Its antero-lateral portions afford attachments to the muscles of mastication and support the jaws and teeth, while its posterior part is liable to vary according to the degree of development of the muscles of the nape of the neck. Next to the brain the most important factor in determining cranial form is the condition of the organs of mastication —muscles, jaws, and teeth. There is strong evidence in favour of the view that the evolution of man from microcephaly to macrocephaly has been associated with the passage from a macrodontic to a microdontic condition. The modifications in the form of the cranium due to the influence of the organs of mastication have been exerted almost entirely upon its external table; hence external measurements of the cranium, as guides to the shape of the cranial cavity and indications of brain development, while fairly trustworthy in the higher races, become less and less so as we examine the skulls of the lower races, of prehistoric man, and of the anthropoid apes.

One of the most important measurements of the cranium is that which determines the relation between its length and breadth and thus divides skulls into long or short, together with an intermediate group neither distinctly dolichocephalic nor brachycephalic. These measurements are expressed by an index in which the length is taken as 100. If the proportion of breadth to length is eighty or upwards, the skull is brachycephalic; if between seventy-five and eighty, mesaticephalic; and below seventy-five, dolichocephalic. Such a measurement is not so simple a matter as it might appear at first sight, and craniologists may themselves be classified into groups according as they have selected the nasion, or depression at the root of the nose, the glabella, or prominence above this depression, and the ophryon, a spot just above this prominence, as the anterior point from which to measure the length. In a young child this measurement would practically be the same whichever of these three points was chosen, and each point would be about the same distance from the brain. With the appearance of the teeth of the second dentition and the enlargement of the jaws the frontal bone in the region of the eyebrows and just above the root of the nose thickens, and its outer table bulges forwards so that it is now no longer parallel with the inner table. Between these tables air cavities gradually extend from the nose, forming the frontal sinuses. Although the existence and significance of these spaces and their influence on the prominence of the eyebrows were the subject of a fierce controversy more than half a century ago between the phrenologists and their opponents, it is only recently that their variations have been carefully investigated.

The frontal sinuses are usually supposed to vary according to the degree of prominence of the glabella and the supra-orbital arches. This, however, is not the case. Thus Schwalbe[1] has figured a skull in which the sinuses do not project as high as the top of the glabella and supra-orbital prominences, and another in which they extend considerably above these projections. Further, Dr. Logan Turner ("The Accessory Sinuses of the Nose," 1901), who has made an extensive investigation into these cavities, has shown that in the aboriginal Australian, in which this region of the skull is unusually prominent, the frontal sinuses are frequently either absent or rudimentary. The ophryon has been selected by some craniologists as the anterior point from which to measure the length of the skull, under the impression that the frontal sinuses do not usually reach above the glabella. Dr. Logan Turner, however, found that out of 174 skulls in which the frontal sinuses were present in 130 the sinuses extended above the ophryon. In seventy-one skulls the depth of the sinus at the level of the ophryon varied from 2 mm. to 16 mm., the average being 5·2 mm., while in the same series of skulls the depth at the glabella varied from 3 mm. to 18 mm., with an average depth of 8·5 mm. It thus appears that the selection of the ophryon in preference to the glabella, as giving a more accurate clue to the length of the brain, is based upon erroneous assumptions, and that neither point can be relied upon in the determination of the anterior limit of the cranial cavity.

The difficulties of estimating the extent of the cranial cavity by external measurements and the fallacies that may result from a reliance upon this method are especially marked in the case of the study of the prehistoric human calvaria, such as the Neanderthal and the Trinil and the skulls of the anthropoid apes.

Statistics are popularly supposed to be capable of proving almost anything, and certainly if you allow craniologists to select their own points from which to measure the length and breadth of the cranium, they will furnish you with tables of measurements showing that one and the same skull is dolichocephalic, mesaticephalic, and brachycephalic. Let us take as an illustration an extreme case, such as the skull of an adult male gorilla. Its glabella and supra-orbital arches will be found to project forwards, its zygomatic arches outwards, and its transverse occipital crests backwards, far beyond the anterior, lateral, and posterior limits of the cranial cavity. These outgrowths are obviously correlated with the enormous development of the muscles of mastication and those of the back of the neck. In a specimen in my possession the greatest length of the cranium, *i.e.* from glabella to external occipital protuberance, is 195 mm., and the greatest breadth, taken between the outer surfaces of the zygomatic processes of the temporal bone, is 172 mm., giving the marked brachycephalic index of 88·21. The zygomatic processes, however, may reasonably be objected to as indicating the true breadth, and the side wall of the cranium just above the line where the root of this process springs from the squamous portion of the temporal bone will certainly be much nearer the cranial cavity. Measured in this situation the breadth of the cranium is 118 mm., which gives a length-breadth index 60·51, and thus represents the skull as decidedly dolichocephalic. The transverse occipital crests and the point where these meet in the middle line to form the external occipital protuberance are much more prominent in the male than in the female gorilla, and the estimate of the length of the cranium in this male gorilla may be reduced to 160 mm. by selecting the base of the protuberance in place of its posterior extremity as the posterior end measurement. This raises the index to 73·75, and places the skull near the mesaticephalic group. At the anterior part of the skull the prominent glabella is separated from the inner table of the skull by large air sinuses, so that on a median section of the skull the distance from the glabella to the nearest part of the cranial cavity is 36 mm. We have here, therefore, another outgrowth of the cranial wall which in an examination of the external surface of the skull obscures the extent of the cranial cavity. Accordingly the glabella cannot be selected as the anterior point from which to measure the length of the cranium, and must, like the zygomatic arches and occipital protuberance, be excluded from our calculations if we desire to determine a true length-breadth index. The difficulty, however, is to select a definite point on the surface of the cranium to represent its anterior end, which will be free from the objections justly urged against the glabella. Schwalbe suggests the hinder end of the supra-glabellar fossa, which he states often corresponds to the beginning of a more or less distinctly marked frontal crest. I have found this point either difficult to determine or too far back. Thus in my male gorilla the posterior end of this fossa formed by the meeting of the two temporal ridges was 56 mm. behind the glabella, and only 24 mm. from the bregma, while in the female gorilla the temporal ridges do not meet, but there is a low median frontal ridge, which may be considered as bounding posteriorly the supra-glabellar fossa. This point is 22 mm. from the glabella, and between 50 mm. and 60 mm. in front of the bregma.

I would suggest a spot in the median line of the supra-glabellar fossa which is crossed by a transverse line uniting the posterior borders of the external angular processes of the frontal bone. I admit this plan is not free from objections, but it possesses the advantages of being available for both male and female skulls. In my male skull the selection of this point diminishes the length of the cranium by 25 mm., thus reducing it to 137 mm. The breadth being calculated at 114 mm., the index is 83·21, and hence distinctly brachycephalic. The length of the cranial cavity is 118 mm. and the breadth 96 mm., and the length-breadth index is thus the brachycephalic one of 81·36.

I have given these somewhat detailed references to the measurements of this gorilla's skull because they show in a very clear and obvious manner that from an external examination of the skull one might easily be misled as to the size and form of the cranial cavity, and that, in order to determine from external measurements the proportions of the cranial cavity, skull outgrowths due to other factors than brain growth must be rigorously excluded. Further, these details will serve to emphasise the interesting fact that the gorilla's skull is decidedly brachycephalic. This character is by no means restricted to the gorilla, for it has been clearly proved by Virchow, Schwalbe, and others that all the anthropoid apes are markedly round-headed. Ever since the introduction by the illustrious Swedish anthropologist Anders Retzius of a classification of skulls according to the proportions between their length and breadth great attention has been paid to this peculiarity in different races of mankind. It has been generally held that brachycephaly indicates a higher type of skull than dolichocephaly, and that the increase in the size of the brain in the higher races has tended to produce a brachycephalic skull. When the cranial walls are subject to excessive internal pressure, as in hydrocephalus, the skull tends to become distinctly brachycephalic, as a given extent of wall gives a greater internal cavity in a spherical than an oval form. In estimating the value of this theory as to the evolutionary line upon which the skull has travelled, it is obvious that the brachycephalic character of the skulls of all the anthropoid apes is a fact which requires consideration.

Although an adult male gorilla such as I have selected presents in an extreme degree outgrowths from the cranial wall masking the true form of the cranial cavity, the same condition, though to a less marked extent, is met with in the human subject. Further, it is interesting to note that the length of the skull is more liable to be increased by such growths than the breadth, since they occur especially over the lower part of the forehead and to a less degree at the back of the skull, while the side walls of the cranium in the region of its greatest breadth generally remain thin.

Few if any fossils have attracted an equal amount of attention or given rise to such keen controversies as the "Neanderthal" and the "Trinil" skull-caps. According to some authorities both these skull-caps are undoubtedly human, while others hold that the "Neanderthal" belongs to an extinct species of the genus Homo, and the "Trinil" is the remains of an extinct genus—*Pithecanthropus erectus* of Dubois—intermediate between man and the anthropoids. One of the most obvious and easily recognised peculiarities of these skull-caps is the very marked prominence of the supra-orbital arches. The glabella-occipital length of the

[1] "Studien über *Pithecanthropus erectus*," *Zeitschrift für Morphologie und Anthropologie*, Bd. i. 1899.

Neanderthal is 204 mm., and the greatest transverse diameter, which is over the parietal region, is 152 mm.—an index of 74·51—while the much smaller Trinil calvaria, with a length of 181 mm. and a breadth of 130 mm., has an index of 71·8. Both these skulls are therefore slightly dolichocephalic. Schwalbe has corrected these figures by making reductions in their lengths on account of the frontal "outworks," so that he estimates the true length-breadth index of the Neanderthal as 80 and that of the Trinil as 75·5. These indices, thus raised about 5 per cent., are considered to represent approximately the length-breadth index of the cranial cavity. A comparison of the external and internal measurements of many recent skulls with prominent glabellæ would, I suspect, show a greater difference than that calculated by Schwalbe for the Neanderthal and Trinil specimens. In a male skull, probably an aboriginal Australian, with a cranial capacity of 1227 c.cm. I found that the glabella-occipital length was 189 mm., and the transverse diameter at the parieto-squamous suture 127 mm., which gives an index of 67·20 and makes the skull decidedly dolichocephalic. The length of the cranial cavity, however, was 157 mm. and the breadth 121 mm. (an index of 77·07 and a difference of nearly 10 per cent.), so that while from external measurements the skull is distinctly dolichocephalic, the proportions of its cavity are such that it is mesaticephalic. It is probable that many skulls owe their dolichocephalic reputation simply to the prominence of the glabella and supra-orbital ridges. An excessive development of these structures is also liable to give the erroneous impression of a retreating forehead. In the Australian skull just mentioned the thickness of the cranial wall at the glabella was 22 mm.; from this level upwards it gradually thinned until 45 mm. above the glabella it was only 6 mm. thick. When the bisected skull was placed in the horizontal position the anterior surface of the frontal bone sloped from the glabella upwards and distinctly backwards, while the posterior or cerebral surface was inclined upwards and forwards. In fact, the cranial cavity in this region was separated from the lower part of the forehead by a wedge-shaped area having its apex upwards and its base below at the glabella.

The cranial wall opposite the glabella is not appreciably thicker in the Neanderthal calvaria than in the Australian skull to which I have already referred, and the form of the cranial cavity is not more masked by this prominence in the Neanderthal than in many of the existing races.

Although the Neanderthal skull is by no means complete, the base of the cranium and the face bones being absent, still those parts of the cranial wall are preserved that are specially related to the portion of the brain which subserves all the higher mental processes. It includes the frontal, parietal, and upper part of the occipital bones, with parts of the roof of the orbits in front, and of the squamous division of the temporal bones at the sides. On its inner or cranial aspect there are markings by which the boundaries between the cerebrum and the cerebellum can be determined. In a profile view of such a specimen an inio-glabellar line can be drawn which will correspond very closely to the lower boundary of the cerebrum, and indicate a horizontal plane above which the vaulted portion of the skull must have contained nearly the whole of the cerebrum.

Schwalbe[1] has devised a series of measurements to illustrate what he regards as essential differences between the Neanderthal skull-cap and the corresponding portion of the human skull. From the inio-glabellar line another is drawn at right angles to the highest part of the vault, and by comparing the length of these two lines we can determine the length-height index. According to Schwalbe this is 40·4 in the Neanderthal, while the minimum in the human skull is 52. He further shows that the frontal portion of the vault, as represented by a glabella-bregmatic line, forms a smaller angle with the base or inio-glabellar line, and that a vertical line from the posterior end of the frontal bone (bregma) cuts the inio-glabellar further back than in the human subject. Prof. King, of Galway, attached special importance to the shape and proportions of the parietal bones, and more particularly to the fact that their mesial borders are shorter than the lower or temporal, whereas the reverse is the case in recent man. This feature is obviously related to the defective expansion of the Neanderthal vault, and Prof. Schwalbe also attributes considerable significance to this peculiarity.

1 "Ueber die specifischen Merkmale des Neanderthalschädels," *Verhandl. der anatomischen Gesellschaft in Bonn*, 1901

Another distinctive feature of the Neanderthal skull is the relation of the orbits to the cranial wall. Schwalbe shows that its brain-case takes a much smaller share in the formation of the roof of the orbit than it does in recent man, and King pointed out that a line from the anterior inferior angle of the external orbital process of the frontal bone, drawn at right angles to the inio-glabellar line, passed in the Neanderthal in front of the cranial cavity, whereas in man such a line would have a considerable portion of the frontal part of the brain-case anterior to it.

From the combined results of these and other measurements Schwalbe arrives at the very important and interesting conclusion that the Neanderthal skull possesses a number of important peculiarities which differentiate it from the skulls of existing man, and show an approximation towards those of the anthropoid apes. He maintains that in recognising with King[1] and Cope[2] the Neanderthal skull as belonging to a distinct species, *Homo Neanderthalensis*, he is only following the usual practice of zoologists and palæontologists by whom specific characters are frequently founded upon much less marked differences. He maintains that as the Neanderthal skull stands in many of its characters nearer to the higher anthropoids than to recent man, if the Neanderthal type is to be included under the term *Homo sapiens*, then this species ought to be still more extended, so as to embrace the anthropoids.

It is interesting to turn from a perusal of these opinions recently advanced by Schwalbe to consider the grounds on which Huxley and Turner, about forty years ago, opposed the view, which was then being advocated, that the characters of the Neanderthal skull were so distinct from those of any of the existing races as to justify the recognition of a new species of the genus Homo. Huxley, while admitting that it was "the most pithecoid of human skulls," yet holds that it "is by no means so isolated as it appears to be at first, but forms in reality the extreme term of a series leading gradually from it to the highest and best developed of human crania." He states that "it is closely approached by certain Australian skulls, and even more nearly by the skulls of certain ancient people who inhabited Denmark during the stone period." Turner's[3] observations led him to adopt a similar view to that advanced by Huxley. He compared the Neanderthal calvaria with savage and British crania in the Anatomical Museum of the University of Edinburgh, and found amongst them specimens closely corresponding to the Neanderthal type.

While yielding to no one in my admiration for the thoroughness and ability with which Schwalbe has conducted his elaborate and extensive investigations on this question, I must confess that in my opinion he has not sufficiently recognised the significance of the large cranial capacity of the Neanderthal skull in determining the zoological position of its owner, or made sufficient allowance for the great variations in form which skulls undoubtedly human may present.

The length and breadth of the Neanderthal calvaria are distinctly greater than in many living races, and compensate for its defect in height, so that it was capable of lodging a brain fully equal in volume to that of many existing savage races and at least double that of any anthropoid ape.

A number of the characters upon which Schwalbe relies in differentiating the Neanderthal skull-cap are due to an appreciable extent to the great development of the glabella and supra-orbital arches. Now these processes are well known to present very striking variations in existing human races. They are usually supposed to be developed as buttresses for the purpose of affording support to the large upper jaw and enable it to resist the pressure of the lower jaw due to the contraction of the powerful muscles of mastication. These processes, however, are usually feebly marked in the microcephalic, prognathous, and macrodont negro skull, and may be well developed in the macrocephalic and orthognathous skulls of some of the higher races. Indeed, their variations are too great and their significance

1 "The Reputed Fossil Man of the Neanderthal," *Journal of Science*, 1864.

2 "The Genealogy of Man," *The American Naturalist*, vol. xxvii. 1893.

3 "The Fossil Skull Controversy," *Journal of Science*, 1864.

too obscure for them to form a basis for the creation of a new species of man. Both Huxley and Turner have shown that the low vault of the Neanderthal calvaria can be closely paralleled by specimens of existing races.

If the characters of the Neanderthal calvaria are so distinctive as to justify the recognition of a new species, a new genus ought to be made for the Trinil skull-cap. In nearly every respect it is distinctly lower in type than the Neanderthal, and yet many of the anatomists who have expressed their opinion on the subject maintain that the Trinil specimen is distinctly human.

Important and interesting as are the facts which may be ascertained from a study of a series of skulls regarding the size and form of the brain, it is evident that there are distinct limits to the knowledge to be obtained from this source. Much additional information as to racial characters would undoubtedly be gained had we collections of brains at all corresponding in number and variety with the skulls in our museums. We know that as a rule the brains of the less civilised races are smaller, and the convolutions and fissures simpler, than those of the more cultured nations, beyond this but little more than that definitely determined.

As the results of investigations in human and comparative anatomy, physiology, and pathology, we know that definite areas of the cerebral cortex are connected with the action of definite groups of muscles, and that the nervous impulses starting from the organs of smell, sight, hearing, and common sensibility reach defined cortical fields. All these, however, do not cover more than a third of the convoluted surface of the brain, and the remaining two-thirds are still to a large extent a *terra incognita* so far as their precise function is concerned. Is there a definite localisation of special mental qualities or moral tendencies, and if so where are they situated? These are problems of extreme difficulty, but their interest and importance are difficult to exaggerate. In the solution of this problem anthropologists are bound to take an active and important part. When they have collected information as to the relative development of the various parts of the higher brain in all classes of mankind with the same thoroughness with which they have investigated the racial peculiarities of the skull, the question will be within a measurable distance of solution.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. DAVID HEPBURN has been appointed professor of anatomy at the University College of South Wales and Monmouthshire, and Dr. T. J. Jehu professor of geology in the University of St. Andrews.

THE distribution of medals and prizes to the students of the Royal College of Science will take place in the lecture theatre of the Victoria and Albert Museum, South Kensington, at 2.30 p.m. on October 8, when an address will be delivered by Prof. Farmer, F.R.S.

EIGHTEEN lectures, open to the public without payment or ticket, will be given at University College, London, during October by professors in the faculties of arts and laws and of science. On October 7 a lecture on "Architectural Evolution," introductory to the work of the School of Architecture, will be given by Prof. F. M. Simpson. Sir William Ramsay will lecture on the gases of the atmosphere, and their connection with radium and its emanations, on October 6.

THE "Education Directory," just published by the Education Committee of the Oxfordshire County Council, shows that the committee has ordered a special survey of the educational conditions of the area over which it has control. Until this inquiry has been held the committee has decided that the higher education of the county shall be carried forward on the lines previously laid down by the Technical Instruction Committee, only modified in so far as last year's Act gives wider powers to the Education Committee.

THE research, statistical and biometric laboratory of University College, London, under Prof. Karl Pearson, offers good opportunities for post-graduate students and research workers in many fields of inquiry. The aim of the department is to give exact training in both observation and computation. Lectures are provided in both elementary and advanced statistics, and the general theory of statistics is so developed as to be of service not only to "biometricians," but to those who propose in the future to deal with social, economic or vital statistics. The training thus gained is far more profitable than any mere examination curriculum for those professions which require powers of careful observation, of original thought, or of accurate computation.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 21.—M. Albert Gaudry in the chair.—Parthenogenesis by carbonic acid obtained with eggs after the emission of the polar globules, by M. Yves **Delage.** It has been shown in previous work by the author that the eggs of the sea urchin are absolutely refractory to the action of carbonic acid. The effect of heat alone, or of shaking alone, gave also negative results, but moderate shaking at 30° C. in presence of carbonic acid was successful in producing the desired result, segmentation taking place in about 60 per cent. of the eggs.—On the production of sugar in the blood during the passage of the latter through the lungs, by MM. R. **Lépine** and **Boulud.** From the experiments described the authors conclude that, during the passage of the blood through the lungs, there is not only a glycolytic, but also a glycogenic process, hitherto unnoticed.—On monodrome functions and differential equations, by M. Edm. **Maillet.**—On the properties and constitution of the manganese steels, by M. Léon **Guillet.** The metallographic and mechanical tests are in perfect agreement with each other, and show that there is great similarity between nickel and manganese steels.—The diagnosis of biliary calculi by preliminary radiography, by MM. **Mauclaire** and **Infroit.**—The germination of orchids, by M. Nöel **Bernard.**

CONTENTS.

THURSDAY, OCTOBER 8, 1903.

MILITARY TOPOGRAPHY.

Recherches sur les Instruments, les Methodes et le Dessin Topographiques. By le Colonel A. Laussedat. Tome ii., part ii. Pp. 287. (Paris: Gauthier-Villars, 1903.)

THE second volume of Col. Laussedat's exhaustive work on topography, which has just been published, deals with the art of metrophotography as developed in Europe generally and in France in particular; condensing the opinions and experiments of leading men of science, and epitomising their results. Attempts to adapt the principles of natural perspective to topography in France date from the middle of the last century. French methods were adopted by Germany in 1865; Italy followed suit in 1875; and in Austria, Maurer executed a military reconnaissance of some importance (which could have been attained in no other way) in 1887. There has gradually accumulated a large amount of scientific literature in Austria dealing with this subject; and in 1889 the Swiss engineer S. Simon had made a photographic survey of Jungfrau. Russia has been busy for many years in the Trans-Caucasus and in Persia, working on similar methods to those of Switzerland, whilst Greece, Brazil and Madagascar have all contributed results of scientific value towards the development of the art. Spain has been interested since 1863, and in 1899 an "excellent ouvrage" was produced in Madrid by two engineers, Iriarte and Navarro, which seems to have been the most complete work on the subject up to the date of Laussedat.

New Zealand and Australia have not been idle; but amongst our colonies it is to Canada chiefly that we look for the most practical experiments leading to the most noteworthy results in this as in every other branch of topographic art. In the United States as early as 1886, photographic methods for rapid reconnaissance were taught at West Point; but it is to the Canadian experts, Deville and Fleurer, that we owe most of our practical knowledge. A general summary of Canadian results will be found in Wilson's useful work on topographic art.

England and English surveyors alone contribute nothing to the world's knowledge ot this branch of surveying, although of all countries in the world England is probably most interested in its development. Colonel Laussedat, noting that as early as 1869 Colonel J. Baillie proposed that photography should be utilised as an aid to reconnaissance, suggests that the absence of all result may be due to the fact that its military application precluded it from publication—"il est probable que des résultats à la fois curieux et utiles ont pu être obtenus dans un ordre d'idées qui ne se prête pas à la publicité." But he is probably unaware that the preliminary art of topography is as yet undeveloped in England; and that we are still a long way from the scientific consideration of any of its more subtle branches. It is true that in India (where the knowledge of topography is an every day practical necessity) some experiments have been made with the Bridges-Lee instrument (the phototheodolite), but there are good reasons why photography as an aid to surveying should only be applicable in exceptional cases and under exceptional conditions in that country. The ultimate practical value of metrophotography lies in the power which it places in the hands of one accomplished topographer to do the work of many. It is a financial question in the long run, but, as Col. Laussedat does not fail to point out, it is useless in the hands of an amateur. It requires a surveyor (or an artist) of exceptional ability and experience as a topographer to render it effective. Workmen of this stamp are rare anywhere and command good value for their work. In India the simpler form of topography attained by the use of the plane table (which is invariably superior in its final results to those of metrophotography when applied to ordinary country by ordinary workmen) is attained cheaply and satisfactorily; for the native labour of India is cheap, abundant, and specially adapted by nature to this form of art. Metrophotography, therefore, would probably not pay.

The practical application of metrophotography has been well exemplified by Le Bon in India, in aid of archæological research; by Legros as an explorer; by Vallot as a mountaineer (in which direction it is specially useful), and by many other Frenchmen in various ways in different parts of the world, leaving no room for doubt as to its value in exceptional circumstances, and the necessity for its continued development. But Laussedat is at some pains to quote the opinion of the Canadian expert Deville, who proves clearly the limitations of the art, and shows that photographic topography is just as much dependent on accurate preliminary triangulation as any other form of topography. He enters fully into the difficulties which beset the method, both as to the determination of scale and the representation of orographic features by contours.

A variety of new instruments designed to aid in the reduction of photographs to plan are described, and the scientific principles involved in their construction are discussed at length—such as the trirègle of Nicholson, the perspectograph of Hermann Ritter, Hanck's apparatus, and the perspecteur panoramique of Ch. von Ziegler. Some of the problems offered for the consideration of his readers are of considerable mathematical complexity. A good deal has been added to that which has already appeared in vol. i. on the subject of telephotography (which was employed with so much success by engineers during the siege of Paris), and forms a particularly fascinating chapter in this work.

A chapter on balloon and kite flying reconnaissance, with an inquiry into the nature of the instruments used and of their attachments, as well as into the principles involved in determining the scale of the resulting photograph and in the reduction of observations, is interesting; although it is difficult to believe that automatic observations taken from flying kites or balloons can be made valuable for military purposes unless applied to the illustration of positions within which two or three points have been accurately fixed

by one of the ordinary methods of terrestrial survey. The results of the first trial in the kite flying for plan photographic purposes were published in *La Nature* by M. Batut in 1888, so that the experiment is by no means new; but we doubt if this system has ever really added any valuable results to the reconnaissance information obtained by more usual methods in time of war; and it is conceivable that only for military purposes under stringent conditions would such methods be applicable. Stereophotography is the subject which concludes Col. Laussedat's review of instruments and methods. This, indeed, forms a most useful variation on ordinary metrophotographic observations, for it is obvious that the representation of orographic features as effected by this well known process conveys a far more readable impression to the eye of the nature of the country photographed, the rise and fall of undulations, the gradation of slopes, &c., than any flat photograph can possibly convey. It is a branch of photography applied to topography which has received very considerable attention in France, and it promises to become a very valuable aid in the process of reducing landscape photographs to topographical maps in future.

Colonel Laussedat has undoubtedly written a most valuable book—one which will be a standard authority for years on the subjects which he treats so ably. Men of science and experts may not agree as to the practical utility of some of the methods discussed; but they are discussed impartially, carefully, and in almost exhaustive detail, and the reader is left to form his own conclusions. There are yet many countries in the world which are greatly in need of good topographical illustration of the natural features contained in them. There are still vast areas unmapped, if not unexplored. Thus Col. Laussedat's book appears at a most appropriate time, when the demand for topography is the first demand of the administrator, and the necessity for utilising every method which promises to effect a saving of time and expense is paramount. It should find a place in every scientific library with any pretension to completeness.

T. H. H.

NATURE STUDY AS A SCHOOL SUBJECT.

An Introduction to Nature Study. By E. Stenhouse. Pp. x + 422. (London: Macmillan and Co., Ltd., 1903.) Price 3*s.* 6*d.*

SINCE the attempt was made a year or two ago to introduce into our rural elementary schools the subject called "nature-study," really such a general introduction to the science of living things as will give the pupil a means of taking an interest in his environment, there has been a great lack of adequate books for the teacher. Several men, Dr. Armstrong, Prof. Miall, and Prof. Lloyd Morgan, for instance, have spoken about the spirit in which the work should be undertaken, nor are there wanting books which indicate the method to be followed, that of experiment and observation. But the ordinary teacher without any particular training in the subject has wanted more systematic guidance, his previous training has been in the wrong direction, and the many text-books that have been hurried on to the market have only tended to confirm his probable original error that nature-study consisted in reading about natural objects or anything bearing on country life.

At last, however, we have a text-book of the right kind, something that we can unreservedly recommend to the teacher, both as a guide to the method he should follow and as a storehouse of instructions concerning the details of experiments within his reach. The book is avowedly written to cover section i. of the Board of Education course in general biology; it is equally well suited to the more recent syllabuses in nature-study or the elementary stage in agriculture and rural economy issued by the same department.

The book opens with a study of the growth of the plant, first describing the elementary experiments illustrating the structure and development of the seedling, then the function of leaf, stem and flower.

A little more might have been done to show how many of the experiments can be rendered quantitative, so as to yield exercises in measurement and continuous record keeping; indications also might have been given of how the teaching could be brought home to the country child by illustrations from farm or garden practice. For example, it is easy to carry out experiments in the garden on the best depths at which seeds of various sizes should be sown, on the necessity of a good seed bed, or the harm wrought by plastering seeds into wet sticky soil, all of which give practical point to the lessons derived from the experiments in class. Again, the structure of the stem finds many appropriate illustrations in the various methods of propagation by cuttings or layers, buds or grafts, the healing of wounds on a tree, knots and other common features in timber.

The discussion of plant families and orders is refreshingly free from technicalities, though here again more might be made of systematic observations from month to month of the development of characteristic structures like tubers, bulbs, corms, &c.

The animal life section gives first of all some elementary instruction about physiology and structure, taking the rabbit as a text, and then discusses briefly the characteristics of our commoner mammals. The section on birds contains a good chapter on the development of the hen's egg during incubation, followed by an account, brief but suggestive, of a few familiar birds. A chapter on the frog and its development from the egg is followed by one on insects, dealing with the structure and life-history of one or two common forms.

The scope of the book is obviously considerable, and it is by no means desirable to use it wholesale, but in the hands of an intelligent teacher who will select the sections most suitable to his conditions, practise himself in the experiments, and then get his pupils to help him to carry out numerous repetitions, who finally will add local illustrations and practical applications, the book will be of the utmost service in systematising his instruction and guiding it along the fruitful lines of experiment and research.

A. D. H.

OUR BOOK SHELF.

Ergebnisse der Physiologie. Edited by L. Asher (Bern) and K. Spiro (Strassburg). Erster Jahrgang. 1 Abtheilung. Biochemie. Pp. xix+929. (Wiesbaden: J. F. Bergmann, 1902.) Price 17 marks.

THE German physiological school is engaged just now in producing a monumental work. Under the able editorship of Drs. Asher and Spiro, two of the most energetic of the younger physiologists of the Fatherland, the most eminent workers in different branches of the science have been persuaded to contribute of their best. We notice also that among the collaborators are several from other countries in addition. The editors do not aim at producing a text-book even for the advanced student, but a series of essays, each written by a master of his craft on some subject to which he has paid particular attention, and has himself made a subject of investigation. Giving, as each article does, not only the history of the subject with full biographical references, but also an account of the latest discoveries, and discussions of conflicting views on the many vexed questions treated, it will prove a veritable mine of facts to the investigator, and will, indeed, be indispensable to all who are attempting real and serious work in the future.

The volume before us treats of what it is now the fashion to call biochemistry, and we notice with pleasure that some of the articles deal with the comparative and also with the botanical aspects of this rapidly growing branch of physiology. We shall not attempt to give a *résumé* of the book, or even a list of the articles and their authors. This is a sort of book which must be read, and not merely talked about. Suffice it to say that among the authors are those of the standing of I. Munk, Hammarsten, F. Voit, Pawlow, Hugo Wiener, and Hofmeister.

In any work in which many participate, there is always a certain amount of inequality. In the present volume this is not so noticeable as in most books of a similar nature, for each author seems to have made a special effort to produce an article or articles of the highest possible standard.

We do not pretend that the book is light or attractive reading, and we imagine that the authors themselves would be the first to repudiate any suggestion that they intended it to be so. The German language, for one thing, does not lend itself to such a frivolous purpose. It is solid, hard reading, written with the German ideal of thoroughness for the student and the worker by those who are themselves workers and students.

Thermodynamik. By Prof. Dr. W. Voigt. Band i. (Sammlung Schubert, vol. xxxix.) Pp. xvi + 360; with 43 figures. (Leipzig: G. J. Göschen, 1903.) Price 10 marks.

THE subject of thermodynamics can be treated either as a deductive or as an experimental science. According to the former method, the second law affords a definition of absolute temperature, and a perfect gas is a hypothetical substance, defined by certain conditions, which is proved to possess the property of acting as a thermometer for the measurement of absolute temperature. In the present case the opposite treatment is followed. The book opens with an introduction dealing with thermometry and calorimetry, followed up by a section on the equivalence of work and heat in which the specific heat of water finds its old traditional title of mechanical equivalent of heat, and the methods of determining it are severally and separately discussed. The next chapter deals with the thermodynamics of perfect gases, and includes sections on Carnot's cycle as applied to such gases. It is not until the third chapter that the second law is applied generally to bodies defined by two variables, while in the fourth or last chapter the principles of thermodynamics are extended to systems defined by any number of variables. The book thus has its parallel, to a certain extent, in those treatises on applied mechanics which deal with the equilibrium of levers or motion of pulleys before introducing the parallelogram of forces or the laws of motion. At the present time many students working in physical laboratories acquire an experimental knowledge of principles which their lack of mathematical ability prevents them from approaching from the deductive side. No doubt this is a pity, but while such students continue to exist and to require teaching, it is difficult to see how a subject like thermodynamics could better be presented to them than is done in Prof. Voigt's treatise.

Arithmetic for Schools and Colleges. By John Alison, M.A., F.R.S.E., and John B. Clark, M.A., F.R.S.E. Pp. xliii+304. (Edinburgh: Oliver and Boyd, 1903.) Price 2*s.* 6*d.*

No better exposition of the nature of arithmetical operations and of proofs of the various rules of arithmetic than that which these two Scottish authors here present to us can be found. The first twelve chapters treat of the more theoretical branch of the subject, and explain with great exactness the laws of arithmetical processes and the manipulation of vulgar and decimal fractions. The authors never miss an opportunity of pointing out the means of shortening a calculation and, at the same time, of explaining and justifying the process. In these first twelve chapters we would specially signalise those on "laws of operations" and "decimal approximations" as interesting to the philosophically minded student; but, indeed, the whole of the work is marked by great thoroughness. In the chapter on evolution, Horner's method is explained and amply illustrated. There is a very good chapter on the metric system, including its employment in dynamics, heat, and electricity, illustrated by a large collection of examples. The nature of ratio and proportion is also very well explained and exemplified in three special chapters. The practical subjects (percentages, profit and loss, interest, &c.) are treated as mere examples of the theory of proportion.

Once only in the book do we meet with a vicious Saxon expression: "If the first term of a proportion be greater than the second, the third *shall be* [instead of *is*] greater than the fourth" (p. 202); but this is not repeated in subsequent similar propositions.

Except by the introduction of the diagrammatical relations between variable quantities, as exhibited by curves on squared paper, it is difficult to see how this very excellent treatise could be improved.

G. M. M.

Les Materiaux artificiels. By Marie-Auguste Morel. Pp. 178. (Paris: Gauthier-Villars and Masson et Cie.)

THIS volume belongs to the "Encyclopédie Scientifique des Aide-Mémoire," published under the general editorship of M. Léauté. It contains information of an interesting kind about numerous materials used in building and other constructive arts. The first chapter, on semi-artificial substances, includes a treatment of lime, cements, bricks, tiles, and other materials. This is followed by successive chapters giving accounts of those artificial materials dependent for their manufacture on technical chemistry; those used in association with metal armatures; those—such as mortar, artificial stone—formed when artificial materials are mixed with other non-metallic substances. The concluding sections include a miscellany of subjects, such as the preservation of wood, the use of soluble glass, and a description of Lincrusta-Walton.

LETTERS TO THE EDITOR.

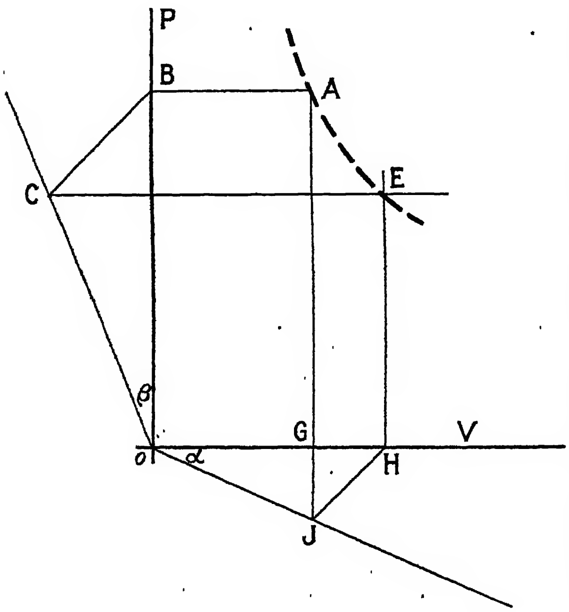
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Expansion Curves.

EVERY man who has studied steam or gas or oil engines knows that if there is one construction more important than another it is to draw a curve representing the law

$$pv^n = \text{constant}$$

through any given point. Here is an exceedingly simple, ingenious method of doing this which I have just found in a pamphlet by Mr. E. J. Stoddard, of Detroit. Let A be the given point so that AB represents a given volume,



and AG a given pressure. Set off any convenient angle, VOJ $= \alpha$ say. Compute an angle β such that

$$1 + \tan \beta = (1 + \tan \alpha)^n,$$

and set off BOC $= \beta$. Produce AG to J. Now make OBC $=$ JHO $= 45°$, and project from C and H to find E a point in the curve. The proof is obvious.

It is evident that OC may be drawn to the right of OB, and OJ above OV, to save paper if necessary.

J. PERRY.

Royal College of Science, S.W., September 23.

Botany in Boys' Schools.

PROF. W. W. WATTS said in his address to the Geology Section of the British Association, "there is no science in which materials for elementary teaching are so common, so cheap, and everywhere so accessible."

In the light of this statement I sought material for the teaching of another science—botany—in a north London playground last week.

The Angiosperms were represented by thirteen natural orders. With a single representative each of the algæ and fungi, thirty-eight species in all were found growing in or on a soil which is almost entirely ballast!

It seems a pity that botany should be so rarely taught in boys' schools when a single playground yields materials "so cheap and so accessible." H. J. GLOVER.

Stationers' School, Hornsey, N., September 23.

Radium and the Cosmical Time Scale.

CERTAIN letters have appeared in NATURE upon the bearing of the properties of radium upon the cosmical time scale. These letters are based on the assumption that radium, or some equally active body, exists in the sun and contributes materially to the output of solar energy. If this assumption were true, we ought, I think, to be able to detect the rays peculiar to radio-active bodies on the surface of the earth—they should bear some proportion to the great stream of light and heat waves which reaches us.

Now a solution of iodoform in chloroform is very sensitive to the β and γ rays. A purple coloration is produced by the rays from 5mg. of radium bromide even after filtering through 1cm. of lead. On the other hand, I find that direct sunlight (if heating be obviated) has no action when the thinnest opaque screen is interposed even after many days. Some of my solutions are now nearly two months old, and they have been exposed in light-tight cardboard boxes to such sunshine as has reached us during that period. They are quite unchanged.

It is, of course, possible that the stream of rays needs to be above a certain critical density in order to decompose the iodoform, but in any case my experiments prove that the β and γ rays reach us at most only in faint quantities from the sun. W. B. HARDY.

Gonville and Caius College, Cambridge.

Loss of Weight of Musk by Volatilisation.

I SHOULD like to direct the attention of your correspondent "S. W." (p. 496) to *N. Cimento* for May, 1902 (or abstract 1986, *Science Abstracts*, 1902), in which E. Salvioni says that he has shown the loss of weight of musk by volatilisation.

The measurements were made by a special form of balance. F. R. SEXTON.

Park Lodge, Kingston-on-Thames, September 5.

CONDENSATION NUCLEI.[1]

IN a previous paper under the not very appropriate title "Experiments with Ionised Air," Prof. Barus has described observations, made by means of his modified steam-jet methods, upon the nuclei found in air which has passed over phosphorus, together with measurements of the electrical leakage through air thus treated. The first chapter of the present volume is taken up with a continuation of the work by the methods there described.

There is no reason to expect the properties of air which has been exposed to phosphorus to be characteristic of ionised air generally; the recent experiments of Harms, and of Elster and Geitel, have, it is true, shown that ions are probably present, but the conditions are much more complicated than in cases of simple ionisation, such as that due to X-rays, owing to the presence of the products of the oxidation of the phosphorus. It is probably to the presence of the products of the oxidation of phosphorus vapour, as was pointed out in 1866 by Schmid, that the formation of the phosphorus cloud is due. The cloud nuclei are not free ions; in the "experiments with ionised air" it was found that the number of nuclei was undiminished by even a strong electric field; additional evidence is brought forward in the first chapter of the present paper, where experiments are described showing different temperatures for the maxima of nucleation and of ionisation. But such evidence was not required to show that these nuclei are not ordinary free ions, for in dust-free air ionised by X-rays or the rays from radio-active substances (in all cases, indeed, in which the ions have the normal velocity under

[1] "The Structure of the Nucleus, a continuation of 'Experiments with Ionised Air.'" By Carl Barus. (Smithsonian Contributions to Knowledge, Hodgkins Fund, 1903.)

a potential gradient of a volt per cm.) the same definite degree of supersaturation, approximately fourfold, is required to produce a cloud; the phosphorus cloud, on the other hand, does not require any sensible degree of supersaturation for its production.

There is evidence in these papers of strange misconceptions on the subject of ionisation. One is surprised in a paper dealing with "ionised air" to find such a statement as that on p. 53, "$n_0=3.6\times10^4$, agreeing very well with J. J. Thomson's 4×10^4 as the number of ions in air ionised to saturation by the X-rays."

In measurements of the leakage of electricity through air which has passed over phosphorus one would expect the apparatus to be designed in such a way that there should be no danger of the leakage observed being mainly due to the surface of the insulating supports becoming conducting by contact with the phosphorus fumes. The failure to take such precautions detracts greatly from the value of the electrical observation described in these papers.

Chapter ii. and the remaining chapters of the volume on the structure of the nucleus contain an account of experiments upon the clouds produced by rapid expansion. There can be no doubt that such experiments are easier of interpretation than those made by steam-jet methods. Prof. Barus begins with experiments on the colour phenomena attending the rapid expansion of moist air containing nuclei, generally phosphorus and "punk" nuclei. It is only when few nuclei are present, and the drops formed on expansion thus comparatively large, that *normal* coronas, as Barus calls them, are seen surrounding a luminous source viewed through the cloud. It is only to such coronas that the ordinary theory of the corona applies; the gorgeous colour phenomena observed when the drops are very small, numerous and uniform in size are much more difficult to interpret. If it were possible to deduce the size of the cloud particles from the colour phenomena observed with a given expansion, a most convenient method of determining the number of nuclei present would be available, for the quantity of water separating out as a consequence of a given expansion can be calculated, and hence the number of drops could be determined if the size of each were known. With this end in view Prof. Barus, in the absence of an exact theory of the colours, attempted to determine the size of the drops corresponding to a given arrangement of colours by an experimental method. On certain assumptions the relative numbers of the drops in a whole series of successive expansions, giving a corresponding series of colour phenomena, were known, the drops in the final expansions being large enough to give normal coronas, from which by comparison with lycopodium coronas the radii of the drops, and hence their number, could be determined; thence could be deduced the number and size of the drops in each of the previous expansions. It is very doubtful if the method can be made a trustworthy one.

Expansion experiments made with other vapours than that of water are next described, benzol, carbon bisulphide, ethyl and methyl alcohol and other vapours being used. Water vapour obviously differs from most other vapours in one very important respect, *i.e.* it is lighter than air. In the experiments made by Prof. Barus the air was contained in a large vessel with a pool of liquid at the bottom; when the liquid was water the moist air would rise to the top, and mixing would thus take place automatically by convection until the whole volume was saturated; in the case of liquids like benzol the heavy vapour-charged air would lie at the bottom, the vapour only gradually diffusing upwards. Uniform distribution of vapour, and hence the production of circular coronas on expansion, are to be expected with water, while with benzol, unless artificial stirring has been employed or a long interval has been allowed for diffusion, only the lowest strata will be saturated with vapour, and the amount of liquid available for each drop formed on expansion will, if the nuclei are uniformly distributed, diminish from below upwards; distorted coronas, or in extreme cases an arrangement of the colours in horizontal strata, are to be expected. The upper part of the vessel may remain free from cloud, the upper boundary of the cloud marking the level at which just enough vapour is present to give drops with the degree of expansion used. Even when uniform distribution of the vapour has been obtained, it will be destroyed by the first expansion made and the subsequent entrance of the dry air introduced to bring the pressure back to that of the atmosphere.

The phenomena observed by Prof. Barus are exactly what one would expect from these considerations, but he makes no reference to the above mentioned important difference in the conditions attending experiments with water vapour and with other vapours. His interpretation of the observed phenomena is, in fact, quite different. "When sulphur or other nuclei are put into the globe containing benzol vapour the result is peculiar. Instead of distributing themselves homogeneously throughout the receiver they usually collect in a heavy band near the bottom. This is invisible until revealed by the first exhaustion, when a heavy sluggish fog bank is seen, only a few centimetres high." Again, "The most curious feature in connection with benzol as well as the preceding liquids is the subsidence of the invisible nucleated air immediately after influx and without exhaustion." The "graded condensation" is interpreted as showing the nature of the distribution in the vessel, not of the vapour, but of the nuclei, and an elaborate series of experiments to determine the rates at which the nuclei travel in different vapours is described; that rate of diffusion of the vapour rather than of the nuclei is involved is by far the more natural interpretation. (In a short paragraph, inserted apparently subsequently to the writing of the paper, the possibility of this interpretation is admitted.)

The fifth chapter treats of the nuclei produced by shaking liquids, particularly aqueous solutions. The production of nuclei by shaking, bubbling and spraying has been noticed by several observers, and the effect of dissolved substances in the water upon the persistence of the nuclei has been studied by Mr. H. A. Wilson. Prof. Barus here gives an interesting series of observations on a large number of solutions of varying degrees of concentration. These nuclei are regarded as minute drops of the solution employed, which have evaporated until the concentration of the dissolved substance becomes great enough to counterbalance the effect of the curvature upon the vapour pressure. The conditions of equilibrium of small drops containing substances in solution are made clear by a diagram. There can be little doubt that the nuclei obtained by shaking solutions, and probably also those produced from phosphorus and from most of the other sources used by Prof. Barus, are of this nature. There is, indeed, nothing novel in the view that nuclei of this kind exist. Barus, however, seems to imply that all nuclei, including what other experimenters have taken to be the ions produced by X-rays and similar agents, are of this type.

An extraordinary interpretation is given (on p. 161) of the experiments by which it was sought to determine the difference in the action as condensation nuclei of the positive and negative ions. "If one introduces nuclei or makes nuclei by aid of the X-rays, in what is virtually the acid and alkaline side of a battery, even if the ionised moist air is the electrolyte,

one is conveying nuclei into or making nuclei out of different media." How it comes about that a perfectly definite degree of supersaturation is required to cause condensation on such nuclei, whether an electric field is applied or not, and whether they have been produced by strong or weak radiation or by other means, he does not attempt to explain. He brings forward in support of his view the further consideration that, "if a marked difference in efficiency of positive and negative ions is granted, then any ionised emanation neutral as a whole, like that of phosphorus, should produce two groups of nuclei. On condensation there should be two groups of coronal particles interpenetrating and subsiding through each other in the way I have frequently instanced in other experiments. No such effect has been observed." The answer to this is simply that the nuclei causing the phosphorus clouds are not free ions, like those produced by X-rays.

Prof. Barus concludes with a suggestion as to the origin of atmospheric electricity, according to which nuclei become negatively charged as the solution which they contain becomes diluted by absorption of water.

C. T. R. WILSON.

THE GEOLOGY OF AUSTRIA-HUNGARY.

TO know, even in a general fashion, the provinces of Austria-Hungary, with their immense range of scenic types and their picturesque variety of nationalities, goes far in itself towards a liberal education. The lover of landscape, as well as the geologist, will find much of interest in the new "Führer für die geologischen Exkursionen in Oesterreich," issued in connection with the ninth International Geological Congress in Vienna. This bulky work is divided, like that of the Russian congress, into numerous separate *brochures*, but forms, none the less, a permanent work of reference for our libraries. To obtain the guide and other publications before they become scarce, a subscription to the secretariat of the congress of twenty-seven shillings or so every three years seems not a heavy price to pay.

In the Austrian guide we have the work of some forty-five authors, describing in a compact and lucid form the districts that they have made their own. In this respect, though covering a far wider field, it resembles that handbook of English geology, the "Geological Excursions," issued by our Geologists' Association. The names of the writers imply in themselves the spirit of a scientific congress. We do not see the groups and cliques seated in the parliamentary Chamber in Vienna, and threatening one another with the literal outpouring of ink; but we find instead a body devoted in common to the reception of the stranger, and anxious that in each province he shall find something memorable and distinctive.

Dr. Jahn opens with the Older Palæozoic area of Bohemia, which includes the Moldau sections above Prag and the ravine at Karlstein, one of the noblest scenes of mediæval Europe. Prof. A. Hofmann describes the silver-mines of Přibram, and Prof. Slavík and others deal with the Cretaceous of northern Bohemia. In this latter paper it is pleasant to note the insertion of the euphonious Tchech names of villages after the German forms, a practice already to some extent imitated in Ireland. August Rosiwal conducts us through the more severely German district of Karlsbad and other health-resorts upon the frontier. Prof. Suess's important theory of the distinction between nascent and "vadose" waters appearing at the earth's surface is duly referred to. If this series of papers leads to a better appreciation of the rural districts of Bohemia, the writers will have done good service. Few visitors have seen what lies upon the plateau and outside the towns—the hamlets with bulbous church-towers, set of necessity beside the lakes, which gather in the hollows of the granite; the broad undulations of a purely agricultural landscape, broken here and there by some magnificent group of castle-towers; the crumpled rim of the country on the south-west, where one plunges down through the forest to Bavaria; or the sheer phonolite necks of the north, rising like islands above a haze formed by the smoke of Cainozoic coal. Here, however, we reach the holiday-region of the Elbe, known to dwellers in Dresden, and pleasantly described and illustrated by J. E. Hibsch in a *brochure* of seventy pages.

Another important series of papers deals with Galicia, the Miocene salt-beds of Wieliczka being, of course, included. Less visited are the petroleum-beds of Borysław, now one of the active fields of enterprise, where the folding of the Miocene strata assigns a maximum age to the uplift of the Karpathians. Oberbergrat Johann Holobek connects the various deposits of hydrocarbons with the extreme fissuring of the sandstones along the region of overfolding. Nearer the great chain, Oligocene menilite-shales are brought up over the Miocene on the south-west limb of the synclinal, and the oil, though flowing in fissures, appears generally accumulated in the bend.

What novelty lies before those who visit Drohobycz, Zaleszczyki, Kasperowce, and Worochta, following Drs. Grzybowski and Szajnocha, can only be known to those who have had glimpses of remote Galicia. Not the least interesting feature of Austrian Poland is the view of the drift-covered Russian plateau across the frontier, and the ever-present sensation of that mysterious and arbitrary *cordon*, along which the white-capped cavalry ride night and day and keep the verge of Europe.

From a geological point of view, the country of the famous limestone *Klippen* is of the first importance. Similar tectonic problems arise wherever beds of varying powers of resistance become crushed together. In a neat section V. Uhlig shows the relation of the northern "Klippenzone" to the overfolds and thrusts on the flank of the Tatra range. The fertile basin of Liptó is included on the south of the granite mass, and one can picture again the streams leaping into it from the forest-slopes of the Karpathians, and the grey crags towering up beyond, and the descent northward on the rain-swept levels of the Magura. This last region of little disturbed Eocene and Oligocene strata leads on to the highly faulted and upturned "Klippenzone." North of this the Older Cainozoic is strongly folded, whence Herr Uhlig concludes that the massive Klippen protected the corresponding beds on their south flank from the pre-Miocene earth-pressures. These same pressures had, however, considerable effect among the Klippen themselves, and have so far squeezed the masses of various ages together as to tend to obliterate unconformities. The author, however, urges that the band of Klippen represents a series of true islands of Jurassic strata in an Upper Cretaceous and Eocene sea, the deposits of which at one time practically overwhelmed them. They are thus not detached fault-blocks without roots, although the pre-Miocene movements have influenced their present prominence and position. Fig. 14 shows the bold character of the resulting scenery. The memoir then describes the structure of the Tatra chain, with a series of sections which will be welcomed by all who aspire to look further than the classic example of the Alps.

Perhaps one regretfully swings back to Salzburg and the Salzkammergut, though the detailed paper by E. Kittl on the stratigraphy of the latter area is accompanied by an admirable bibliography and a map

in colours. Yet why should one regret that a region of such preeminent scenery lies comparatively near us, and is at times unconformably overstepped by the non-geological tourist? The next series of papers carries us away to Styria and the valley of the Mur, where miles of torrent and ravine, of grey limestone crag above and sunny maize below, await the unconventional traveller, and lure him ever eastward, until he emerges on the plain of Hungary. Then follows a number of papers on the environs of Vienna, a city set so happily in a land of geological contrasts. Until we have seen and touched it, we scarcely realise that, a few miles south of Laxenburg, the dusty rise over a castle-crowned projection represents the passage of the Alps. South-west lies the true mountain-episode of the Semmering, fully expounded, with a fine map, by Franz Toula. Westward, we have the narrows of the Danube, and the variety of cliff and alluvial meadow so charmingly described by Prof. Penck. The river runs between Melk and Krems in a pre-Glacial valley, much of which was actually excavated before Oligocene times. The surface-features must originally have been very different, to allow of the formation of this deep cut across the southern projection of crystalline rocks, which almost connects Bohemia with the Alpine system.

The Dolomites, the Adige valley, and Predazzo still offer problems for many a friendly battle. The Carnic Alps present a newer field, and include the superb ravine of Pontebba, with a side-excursion to the limestone-fastness of the Predil. This comparatively low pass, with its fine angle on the south side, amid a veritable world of rocks, would in itself show how much awaits the tourist who will venture east of Venice.

Hungary will probably be dealt with in a special treatise for those who made the long excursion on the Danube. Bosnia and the Hercegovina are very briefly touched on, since the local government has prepared a separate "souvenir" for visitors. What this attention means will be appreciated by those who have experienced the hospitality of the "occupied provinces." From a congress down to the humble bicyclist, all receive a welcome in this old Slavonic highland, all visitors alike are considered of interest to the State. When one sits by the stream-side in some level *polje*, a lake-basin of Miocene times, and hears the muezzin call from the little wooden mosque among the trees, or when one chips the gabbros in the grim ravine of the Narenta, while sun-browned hill-men, like stage-bandits, stride gravely past upon the road, then one can realise, with a grateful heart, what Austria-Hungary means, not only to the geologist, but to Europe.

GRENVILLE A. J. COLE.

NOTES.

A COMMISSION has been appointed by the French Navy Board to inquire into the migrations of the sardine and the causes of the disappearance of this fish. The commission includes Prof. Vaillant, of the Paris Natural History Museum; M. Fabre Domergue, Inspector-General of Sea Fisheries; and M. Canu, director of the agricultural station at Boulogne-sur-Mer.

OWING to the appointment of Dr. Martin to the directorship of the Lister Institute, the chair of physiology is vacant at the University of Melbourne. Particulars as to duties, emoluments, &c., will be in the hands of the Agent-General for Victoria after October 8. The new professor will be required to commence his duties on March 1, 1904.

AN international exhibition of the manufacture and industrial applications of alcohol will be held in Vienna in April and May, 1904.

A PRESS despatch from Berlin states that the Imperial budget for 1904, now in preparation, allots 7500*l*. for combating typhus, which is specially virulent in Bavaria, Prussia and Alsace-Lorraine.

AN international congress on school hygiene is to be held at Nuremberg from April 4–9, 1904, under the presidency of Prof. Griesbach, of the University of Strassburg. The general secretary is Dr. Paul Schubert, to whom all communications relative to the congress should be addressed.

A REUTER telegram from Rio de Janeiro of October 1 states that the Brazilian Chamber has adopted the third reading of the Bill to establish an international steerable balloon competition to be held at Rio in 1904. The scheme has been submitted to the Senate.

MR. H. MAXWELL LEFROY, who has been appointed entomologist to the Government of India, is to be stationed at Surat, in the Bombay Presidency, pending the establishment of the permanent headquarters of the Imperial Agricultural Department now being organised under the orders of Lord Curzon.

THE necessary legal formalities in connection with the change of name of the Jenner Institute have now been completed, the Board of Trade having sanctioned the new name. The Institute will, therefore, now be known as the "Lister Institute of Preventive Medicine." The address, Chelsea Gardens, S.W., remains the same.

SIR THOMAS HANBURY has promised the Pharmaceutical Society of Great Britain securities of the annual value of 25*l*. for presentation with the Hanbury gold medal awarded biennially for research in the natural history of drugs. The medal, founded in memory of Daniel Hanbury, brother of Sir Thomas, was awarded this year to M. Eugène Collin, of Paris. As the result of Sir Thomas Hanbury's gift future recipients of the medal will also receive the sum of 50*l*.

A PROVISIONAL programme of the ordinary meetings of the Royal Geographical Society for the session 1903–4 has been published. Among the subjects to be dealt with in the meetings of this year we notice north polar exploration, 1898–1902, by Commander R. E. Peary, and the Patagonian Andes, by Colonel Sir T. H. Holdich. The arrangements made for meetings after Christmas include, among others, the Gulf Stream, by Mr. H. N. Dickson; the régime of the Nile, by Sir William E. Garstin, G.C.M.G.; the lakes of New Zealand, by Mr. Keith Lucas; and some adventures in Antarctic lands and seas, by Lieutenant E. H. Shackleton (Christmas lecture to young people).

A KITE-FLYING competition was held at the Alexandra Palace on Saturday last under the auspices of the Aëronautical Institute. The length of wire or string to be used was limited to one mile, and marks were awarded on the following points:—(*a*) The manner in which the kite leaves the ground; (*b*) the manner in which it ascends; (*c*) the steadiness of the kite; (*d*) the length of time required to let out the whole mile of wire or string; (*e*) the greatest average of the altitude as taken by a series of observations during the course of one hour; and (*f*) the rapidity and manner of descent. Only three competitors put their kites to the test, and the contest was easily won by Mr. S. F. Cody, whose kite quickly reached the limit distance and remained steady at that altitude in a strong wind. The kite used was one of a number which is being prepared for consignment to Portsmouth Dockyard.

AN influentially signed memorial on the subject of the improvement of agriculture was recently sent to the Government of Bombay, and is summarised in the *Pioneer Mail.* The memorialists propose that two botanic gardens should be established, one at Poona and one near Bombay, the former as the centre of investigation for the Deccan, and the latter for the Konkan and Gujarat. Each garden should be provided with a herbarium and with chemical and botanical laboratories, and to each should be attached a farm for agricultural and horticultural experiments. It is suggested that the scientific staff might be one chief botanist, one assistant botanist for Poona, one assistant botanist for Bombay, one chemist, one entomologist, and one mycologist. It is also suggested that the number of the experiment stations should be increased and the scope of the experiments extended; that local bodies should be encouraged by grants in aid to conduct experiments on lines prescribed by the department; that publicity should be given to the work of the department, and results of practical interest should be communicated through leaflets printed in the vernacular; that further measures for the improvement of agricultural stock should be taken by the State; and that the Forest Department should be invited to cooperate with the Agricultural Department in the work of experimenting with products likely to succeed in forest areas.

THE method of scientific investigation by observation and experiment was touched upon by Mr. Sidney Lee at the Working Men's College on Saturday last, in the course of a lecture on Bacon, who advocated and inaugurated the revival of experimental philosophy. Bacon's main anxiety, said Mr. Lee, was to see research in every branch of science adequately endowed and equipped, and in his "New Atlantis" he planned in somewhat fanciful language a great palace of invention, a great temple of science, where the pursuit of knowledge in all its phases was to be organised on principles of the highest efficiency. Whether a temple of science on the scale that Bacon imagined it would ever come into existence remained to be seen. At present the portents were not favourable for its emergence in this country. It seemed more likely to come first to birth in Germany or in America, where things of the mind received from the general public a consideration which was denied them here. The experience of a recent visit to America showed Mr. Lee that there was nothing here to compare with the widespread eagerness among the youth of the United States to enjoy academic scientific training. England's prestige owed very much to the triumphs won by men who were Bacon's disciples in methods of scientific research, many of whom stood indebted to ancient educational benefactors. Bacon was well alive to the means whereby a nation's intellectual prestige could best be sustained. He argued that for a nation to apply a substantial part of its material resources to the equipment of scientific work and exploration, a share of its resources which should grow greater with the growth of population and the increasing complexity of knowledge, was the surest guarantee of national glory and prosperity.

IN the report of observations made at the Bombay Government Observatory in the years 1900 and 1901, a feature which differentiates it from the reports of previous years is the prominence given to records obtained from seismographs. In the previous report a series of seismograms and a register of disturbances obtained from a Milne seismograph were given. These are now supplemented by similar information derived from a pair of heavy horizontal pendulums, which record with ink on a metal cylinder, and which have a sensibility for tilting three or four times that of the Milne apparatus. The chief differences in the records obtained from these two types of instruments are the ratios of the recorded amplitudes. These differ so widely that it may be inferred that "the dominant feature of the movements in the majority of disturbances does not indicate tilt." We are not told, however, whether the free periods of the three horizontal pendulums are identical or different.

M. E. ESTANAVE contributes to the *Journal de Physique* a list of the theses in mathematical and experimental physics presented for the doctorate of science in French universities during the nineteenth century.

MR. P. E. JOURDAIN contributes a note on Gauss's principle of least constraint to the *Mathematical Gazette*, and a general theorem on the transfinite cardinal numbers of aggregates of functions to the *Philosophical Magazine* for September.

A COMPARISON of Maxwell's theory with the older and newer theories of electromagnetism is given by Mr. Emil Cohn in the *Physikalische Zeitschrift* for September. It is pointed out among other conclusions that Maxwell's theory accounts in the simplest way for those phenomena which it is competent to explain.

IN a note contributed to the Lombardy *Rendiconti*, Prof. M. Cantone discusses the question whether the elastic constants of a substance are affected by the surrounding medium. The results obtained negative the idea of any such connection. In determining the torsional rigidity of platinum and caoutchouc filaments, the immersion of the filament in water produced no deviation in the torsion balance.

IN the *Proceedings* of the Physical Society, Dr. G. J. Parks describes some experiments on the thickness of the liquid film formed by condensation on the surface of the solid. In the case of cotton silicate, it was found by weighing the material before and after condensation that the thickness of the film came out to be about $13 \cdot 4 \times 10^{-6}$ of a centimetre, and when the film had reached this thickness no heating was produced on immersing the silicate in water.

THE *Journal* of the Western Society of Engineers contains a description of the latest experiments in aërial gliding by Mr. Wilbur Wright. A noticeable feature of these experiments is that the machine sustained as much as 165 lb. to the horse-power as contrasted with 28 in Mr. Maxim's machine and 31 in Prof. Langley's model of 1896. Furthermore, while Mr. Chanute's best experiments in 1896 gave angles of descent of 7½ to 11 degrees, Mr. Wright has succeeded in gliding at angles of 6 to 7 degrees, and even, in one case, at as low an angle as 5 degrees.

IN the *Rivista d'Italia*, Mr. Italo Giglioli, director of the agricultural station at Rome, deals with certain agricultural questions affecting the south of Italy. After reviewing the principal vegetable products now produced by Italy the author suggests, as possible outlets for fresh enterprise, the cultivation of (1) the camphor plant (*Laurus camphora*); (2) the insecticide *Pyrethrum cinerariaefolium*; and (3) the india-rubber plant (*Ficus elastica*). The author sees no reason why the production of india-rubber in Italy should not be a success.

PROF. ALESSANDRO VOLTA, in a note appended to a paper in the Lombardy *Rendiconti*, directs attention to an unpublished manuscript of Volta in which it is stated that negative electricity is dissipated with three times the facility of positive electricity. It thus appears that the difference

of the two electricities in their behaviour in electric discharges was known to Volta. Attention is also directed to remarks by Volta on flame discharges, in which it is asserted that such discharges are not affected by the smoke produced. Prof. A. Volta's own researches show that flames of oil, petroleum, gas, and alcohol have approximately the same resistance, but for alcohol flames containing copper chloride the resistance is lower.

THE August number of the *Journal* of the Royal Microscopical Society is mainly devoted to optical theories of the microscope. This subject is introduced by a paper on Helmholtz's theory by Mr. J. W. Gordon, in addition to which Lord Rayleigh's paper from the *Philosophical Magazine* of 1896 is reprinted, together with a further communication from the same writer, and remarks by Dr. Johnstone Stoney, Dr. Siedentopf and others are reported in the Society's *Proceedings*. Among important points under discussion is the property that there is no theoretical limit to the smallness of an isolated luminous object which can be visible through the microscope. The limitations imposed by the undulatory theory affect only the distance apart of two objects or the fineness of structures in order that they may be capable of resolution.

WE have received a circular issued under the auspices of the German Ornithological Society, and signed by Mr. J. Thienemann, of Rossitten, Keer, Nehrung, East Prussia, directing attention to an experiment about to be made with the view of increasing our knowledge of the seasonal wanderings of birds. During the present autumn and next spring it is proposed to capture at Rossitten some hundreds, or perhaps thousands, of rooks (or crows?), upon the foot of each of which is to be fastened a metal ring bearing a number and the date of capture, after which the birds are to be set at liberty. Whenever such marked birds are killed, it is requested that the leg bearing the ring may be cut off and forwarded to Rossitten, with a label recording the date and place of capture.

THE latest issue (vol. xxxi. parts ii. and iii.) of Gegenbaur's *Morphologisches Jahrbuch* appears in mourning on account of the death, in June last, of its learned founder, who superintended the journal nearly to the completion of the twenty-ninth volume. A full biography is promised in the next number. Among the contents of the present issue is an article on the comparative anatomy and development of the heart and aorta in vertebrates, by Mr. A. Greil, and a second, by Dr. K. Fürbringer, on the visceral skeleton of sharks and rays. In a third, Mr. K. Gehry demonstrates that the bunch of axillary muscles ("Achselbogen") in man really represents the panniculus carnosus of lower mammals.

THE first part of the "Aarbog" of the Bergen Museum is devoted entirely to descriptions of the invertebrate fauna of Norway and its seas. Miss E. Arnesen contributes the second instalment of her account of the sponges, dealing in this section with the halichondrine group of the Monaxonida. The nemertean worms are described at considerable length by Mr. R. C. Punnett, of Cambridge, who records a number of new species collected by himself and Dr. Nordgaard in the fjords round Bergen in the summers of 1901 and 1902. Another article, by Mr. E. T. Browne, of University College, London, deals with medusas from Norway and Spitsbergen, among which are several novelties.

WE have received vol. xxxiii. part ii. of *Travaux de la Société Impériale des Naturalistes de St. Pétersbourg*. Its contents include an article on biological method in "zoopsychology," by Mr. W. Wagner, a second, by Mr. H. Goebel, on the birds of Lapland and the Solovetski Islands, and a third, by Mr. K. St. Hilaire, on the change of substance in cells and connective tissue. The latter article is largely based on the acid-secreting glands of molluscs. As regards the birds of Lapland, the author finds that out of a total of 198 species, 133 are certainly known to breed in that country, while another 34 probably do so. Of the remainder, 17 are stragglers and 6 winter visitors, while 1 is a pelagic species, and the other 7 are found only in the Solovetski Islands.

THE September number of *Animal Life* contains an article by Mr. Lydekker on local variation in the giraffe, illustrated by one coloured plate and a number of photographic reproductions from paintings. After referring to the marked differences between the Somali giraffe (*Giraffa reticularis*) and the typical *G. camelopardalis*, the author points out that evidence is gradually accumulating as to the existence of a number of local races of the latter. The article is chiefly based upon specimens now, or recently, living in the Duke of Bedford's collection at Woburn and in the Zoological Society's Gardens, and on two mounted examples in the Natural History Museum. The Woburn and Regent's Park forms are definitely identified, but, owing to the unsatisfactory nature of the description of two subspecies founded by a German writer, the author has refrained from giving names to the British Museum specimens, which clearly indicate distinct races. A name is, however, assigned to the Congo giraffe.

AN official report has been issued in Simla on the mortality caused by wild beasts and snakes in India. In 1902 the total mortality caused by wild animals was 2836, of which 1046 are reported as being due to tigers, and deaths reported from snake-bite numbered 23,166. In addition 80,796 cattle were destroyed by wild animals, and 9019 by snakes. The number of wild animals for the destruction of which rewards were paid in 1902 was 14,983, of which 1331 were tigers; the number of snakes killed was 72,595. The amount paid in rewards for the destruction of wild animals was Rs. 1,00,987, and for the destruction of snakes Rs. 3529.

A NOTABLE contribution to the subject of proteid metabolism is made by Mr. E. Godlewski in a paper which appears in the *Bulletin international de l'Académie des Sciences de Cracovie*. The general conclusions arrived at are that flowering plants, *i.e.* germinating seedlings as well as fungi, can, in the dark and in an atmosphere devoid of CO_2, absorb and work up nitrogen from nitrates even to the extent of building up proteid substances; but for the continued formation of proteids to any considerable extent a supply of plastic carbohydrate must be present in order to furnish the energy required, such, for instance, as the sugar or starch present in germinating tubers or bulbs. Also, according to the author, light has a direct as well as an indirect action in increasing the amount of proteid substances formed.

A SMALL brochure on "Propagating Plants," written by Mr. D. S. Fish, of the Royal Botanic Garden, Edinburgh, will be found useful by amateur gardeners who wish to obtain practical information on the methods of raising seedlings, striking cuttings, and similar matters. It is published by Messrs. Dawbarn and Ward, London.

THE "Guide to the Sydney Botanic Gardens," which has been prepared by the director, Mr. J. H. Maiden, with assistance from other members of the staff, bears witness to the wealth of vegetation which has been planted round

Farm Cove, a bay in the famous harbour of Port Jackson. The collections of cycads and conifers, including nearly a dozen species of both Macrozamia and Podocarpus, are particularly noteworthy. The plan adopted in the "Guide" is to give a list of the important plants to be found in each bed, with brief notes on native and the more interesting foreign species.

Two handy little publications have been issued by Messrs. James Woolley, Sons, and Co., Ltd., of Manchester. One, known as the "Science Teacher's Pocket Book and Diary, 1903–4," costs a shilling, and the other, the "Science Student's Note Book, 1903–4," costs 6*d*. Both books contain about forty pages of useful constants in physical and chemical science, together with other numbers in constant use in the laboratory.

MESSRS. ASTON AND MANDER are now manufacturing for the use of technical and other schools drawing instruments provided with several useful improvements. The adjusting screws cannot be detached from the instruments, and so be lost, the inking-in pens are easily cleaned, and a patent hook-and-nut method of holding the needles effectually prevents breakages when clamping, and renders it easy to change the needles.

SEVERAL volumes of the first annual issue of the "International Catalogue of Scientific Literature" have recently been received. The volume on chemistry (part ii.) contains 671 pages, referring to papers published since the end of 1900. The literature published in 1901, together with a portion of that published in 1902, is catalogued in the volumes on palæontology, general biology, human anatomy, physical anthropology, and physiology (part ii.); the last volume includes papers on experimental psychology, pharmacology, and experimental pathology, and occupies 664 pages.

COPIES have been received of the last two half-yearly volumes—xxxii. and xxxiii.—of the *Journal* of the Anthropological Institute of Great Britain and Ireland. Among numerous other important contributions, the earlier volume contains the Huxley lecture for 1902, on right-handedness and left-brainedness, by Prof. D. J. Cunningham, F.R.S. The more recent volume includes the address by the president, Dr. A. C. Haddon, F.R.S., delivered at the annual general meeting of the Institute in January last. The volumes are profusely illustrated with beautifully reproduced plates, and serve to show the excellent work the Institute is doing. Similar researches are, in the United States and elsewhere, liberally subsidised by the State, but the Anthropological Institute, working without such support, is enriching the Empire by collecting and publishing a mass of well-arranged information of which any scientific department might legitimately be proud.

THE additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Anthropopithecus troglodytes*) from the Albert Nyanza, a Patas Monkey (*Cercopithecus patas*) from Gondokoro, presented by Colonel Bruce; two Geoffroy's Cats (*Felis geoffroii*) from Chaco, Argentina, presented by Mr. A. C. Crewe; a Puma (*Felis concolor*), two Vicunas (*Lama vicugna*), a Condor (*Sarcorhamphus gryphus*) from Puna de Jujuy, presented by Baron Ott; a Rosy-faced Love-bird (*Agapornis roseicollis*) from South Africa, presented by Mrs. Healey; a Mandarin Duck (*Æx galericulata*) from China, presented by Mrs. Balston; two Wagler's Pit Vipers (*Lachesis wagleri*) from Singapore, presented by Mr. A. Herbert; a Back-marked Snake (*Coluber scalaris*), European, presented by Mr. W. A. Harding; four Horned Lizards (*Phrynosoma cornutum*) from Colorado, presented by Mr. Edwin Webb; two Carinated Lizards (*Liocephalus carinatus*) from the West Indies, five Hispid Lizards (*Agama hispida*) from South Africa, five Round-spotted Lizards (*Stenodactylus guttatus*) from North Africa, five Black-spotted Lizards (*Algiroides nigropunctatus*) from the Borders of the Adriatic, two Wall Lizards (*Lacerta muralis*, var. *genéi*), two Wall Lizards (*Lacerta muralis*, var. *badriagoe*) from Corsica, two Alaska Geese (*Bernicla minima*) from the Pacific Coast, deposited.

OUR ASTRONOMICAL COLUMN.

THE ROTATION OF SATURN.—Writing to the October number of the *Observatory*, Herr Leo Brenner states that the rotation period of Barnard's large white spot on Saturn, as deduced from his observations, is *exactly* 10h. 38m., and that this value is rigidly confirmed by the observations of other German observers.

This period exactly agrees with that obtained by Mr. Denning as a mean of all the published observations, and, as that observer points out in a communication to the above-named journal, it indicates that the various belts and zones on Saturn have different rotation periods in a manner similar to those of Jupiter.

The recent disturbances on Saturn have now practically subsided, and can only be seen with the larger instruments.

THE BROADENING OF SPECTRAL LINES.—In a paper communicated to No. 34 vol. vi. of the *Philosophical Magazine* Mr. G. W. Walker discusses the causes which lead to the asymmetrical widening of spectral lines.

Taking it for granted that near to a luminous source, whether the luminosity be produced by electricity or by flame at high temperature, there must be a number of free negatively charged particles, he proceeds to show how these particles may modify the light which they receive, and again scatter it in a manner quite different to that obtaining in the "Doppler" or in any "damping" effect. These charged particles, under the influence of the plane waves, will then vibrate with a period different from that of the incident waves; thus, instead of homogeneous light, there will be a portion of the light scattered by the charged particles, and this portion will have a longer wave-length than the original light, its intensity varying in proportion to the number of freely charged particles present. This, however, does not account for those rare cases where the broadening takes place on the violet side of the normal line. To explain these cases Mr. Walker suggests that the continuous streams of charged particles will set up a magnetic field which may produce the Zeeman effect, in which Zeeman has frequently noted asymmetrical broadening towards the violet. Where this latter effect is greater than the former, then the broadening takes place on the violet edge of the original line.

THE SPECTRUM OF HYDROGEN.—With the purpose of elucidating the connection between the "four-line" spectrum and the "many-line" spectrum of hydrogen, Mr. Louis A. Parsons, of the Johns Hopkins University, has made a series of experiments dealing with the spectrum of hydrogen obtained under many various conditions, and has embodied his results in a paper communicated to No. 2 vol. xviii. of the *Astrophysical Journal*.

After discussing the various theories which have previously been put forward in explanation of the phenomena, and dealing especially with that of Prof. Trowbridge, who supposes that the line spectrum is due to water vapour, and not to hydrogen pure and simple, Mr. Parsons describes the various pieces of apparatus he used and the experiments he performed, and then summarises his results in the following conclusions:—(1) The compound spectrum never occurs without the line spectrum, although the latter may occur alone at high pressures; (2) the line spectrum is characteristic of an abruptly oscillatory discharge, whilst the compound spectrum is produced by the continuous discharge; (3) the line spectrum may be produced by high temperatures occurring *locally* at points where the disruptive dis-

charge occurs, but it is not due to the high temperature of the gas considered as a whole.

In regard to the fourth point, viz. the action of water vapour in producing the line spectrum, the experiments showed that the presence of moisture is an important factor in the production of this type of spectrum, but they do not lead to Prof. Trowbridge's conclusion that it is the spectrum of water vapour. Mr. Parsons is inclined to believe that the ionisation of the atoms, as they enter or leave the water molecule, may set up a distinct local oscillatory discharge, which he previously shows to be necessary for the production of the line spectrum.

THE ORBIT OF ξ BOÖTIS.—In a previous computation of the orbit of ξ Boötis, by Prof. W. Doberck, the elements obtained represented the observed angles up to the year 1888, but did not faithfully represent the observed distances for some time prior to that (*Astronomische Nachrichten*, No. 2129). It now appears that the angles might be represented by orbits having widely differing periods, so the same observer has recomputed the elements, mainly using the measured distances as is done in the case of η Cassiopeia. Using Thiele's method, which he recommends especially in the case of very eccentric orbits, he obtained the following elements, referred to the equinox of 1900·0, from normal places for 1836·5, 1876·5, and 1896·5 (*Astr. Nach.*, No. 3900):—

$\Omega = 183^\circ\ 8'$	$P = 140{\cdot}84$ years.
$\lambda = 314\ 6$	$T = 1907{\cdot}10$
$\gamma = 46\ 8$	$a = 5''{\cdot}115$
$e = 0{\cdot}6163$	Retrograde.

IN the *Memorie* of the Italian Spectroscopists' Society Mr. G. Boccardi gives a list of errata in various star catalogues and trigonometric tables which he discovered in the course of compiling the catalogue of stars of reference in the zone 46° to 55°, published by the Observatory of Catania. In addition, the same writer gives corrections for the ephemerides of the asteroid 292 Ludovica. An Italian translation, by Mr. A. Mascari, of Dr. W. J. S. Lockyer's paper on a probable relation between the solar protuberances and the corona is also published in the *Memorie* of the Society.

OPENING OF THE MEDICAL SCHOOLS.

AS usual at this time of the year, introductory addresses have been delivered during the past week at the opening of the various medical schools in different parts of the country. Some of these addresses are summarised below.

At the opening of the medical session at University College, London, on Monday, Prof. E. H. Starling, F.R.S., pleaded for the establishment of a post-graduate school of medicine. He remarked that the crying need at the present time was clinical research, which must be carried out in hospitals by men trained in scientific methods and willing to spend laborious days in their application to the problems of disease. The absence of workers who might utilise to the full the great mass of material presented by our hospitals was due to two factors, namely, the absence of academic ideals in London, and the lack of any adequate provision which might enable our best men to devote their early years to the advance of their profession by conscientious study and research. Prof. Starling advocated the foundation, in the University of London, of a school specially devoted to the advancement of medicine. Such post-graduate school must be in connection with a hospital, and might be founded by a modification of one of the existing medical schools, or be created *de novo* in connection with some general hospital. Forming part of the school should be laboratories for experimental physiology and pathology, for bacteriology, for medical chemistry, and for normal and morbid histology. In addition to the experimental department, there should be, preferably in the hospital building itself, a series of observational laboratories, where the conditions of the patients could be investigated with a scientific precision. Such a school could detract in no way from the present advantages of our medical schools, but would rather add to their efficiency.

Sir Victor Horsley delivered an address on the subject of university education at the University of Birmingham on Monday. In the course of his remarks he urged the necessity for a multiplication of universities, and deprecated Sir W. Anson's dictum that what was wanted before universities was "an intelligent population." Under the present Government the whole direction of the Education Department had been placed in the hands of those whose ideas were regulated by the sterile training in dead languages and somewhat moribund systems of philosophy, unfortunately characteristic of an old university like Oxford. It did not seem to have occurred to the Parliamentary Secretary to the Board of Education that to the ordinary person the more obvious way of obtaining an intelligent population was to provide them with the highest and best means of educating themselves, and to increase and multiply those means in the midst of each populous district. It seemed to him shocking that the leading expert of the Education Department should hostilely attack not merely the present evolution of universities, but also the very earnest and carefully thought out propositions which the president of the British Association recently put forward with fresh force and interest. It had been reserved for Sir William Anson to raise the barren and worn-out strife between classical and scientific education. How could the physical science laboratories of our universities be considered to be too favoured by public opinion, as Sir William asserted, when their equipment and buildings left so much to be desired, and their endowments were so meagre that some 24 millions, it was estimated, must be expended to bring them into line with the universities of America? It was most unfortunate for the nation that the educational policy of the present Government was directed by officials holding such reactionary views. Let them hope that when the greatest statesman of our generation was placed by the country in his proper position as Prime Minister and leader of the nation a change would come over the spirit of the Education Department. The nation was under the delusion that universities flourished, first, on private endowments and benevolence; and, secondly, on the fees of students. Legislation to provide State aid for the universities was a duty which pressed heavily on a Government which did nothing to protect the people from the injury of drink and the waste of money which the drinking habit entailed. He suggested that the universities should cooperate in pressing a definite programme of State aid.

The first autumn term of the faculty of medicine at the University of Liverpool was inaugurated by Sir Dyce Duckworth, who, during an address on reverence and hopefulness in medicine, told the students that to equip themselves fittingly for the profession of medicine would demand some knowledge of the several sciences on which the science and art of medicine are based. Those who have had experience as examiners know well the difference, said Sir Dyce Duckworth, between candidates who have had the benefit of a liberal education before they entered upon medical study, and those who, although showing aptitude, have not had that advantage. It is the difference between efficiency and expertness, between width and narrowness.

Dr. J. W. Swan, F.R.S., gave the introductory address to the school of pharmacy of the Pharmaceutical Society. The events of the last sixty years, he said, showed conclusively that our want of thoroughness in education and the consequent want of imagination and capacity to appreciate the value of scientific research had caused us immense national loss. Dr. Elizabeth M. Pace, in addressing the students of the London School of Medicine for Women in connection with the Royal Free Hospital, gave an interesting historical sketch of the growth of facilities for the medical education of women during the last sixty years. At the Middlesex Hospital Mr. Justice Wills presided at the opening of the session, and Mr. William Hern, in welcoming the new students, pointed out that one of the great differences between the medical methods of past and present times was the substitution for the old empiricism, of treatment based upon an inquiry into the causes of disease. Mr. J. A. Bloxam, in the inaugural address at the Royal Veterinary College, told the students that if veterinary education was to march with the times, and if this country was to bear its part in the advancement of veterinary knowledge in the future, the State must follow the example set by other countries and contribute handsomely to the equipment and upkeep of the veterinary schools.

THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS BY A. C. SEWARD, F.R.S., FELLOW AND TUTOR OF EMMANUEL COLLEGE, LATE FELLOW OF ST. JOHN'S COLLEGE, CAMBRIDGE; LECTURER ON BOTANY IN THE UNIVERSITY, PRESIDENT OF THE SECTION.

IN 1883, the date of the last meeting held by the British Association at Southport, the late Prof. Williamson, of Manchester, delivered a Presidential Address before the Geological Section, in which he reviewed recent progress in palæobotanical research, with special reference to the vegetation of the Coal period. It would have been an interesting task to traverse the same ground to-day, in order to show what a vast superstructure has been built on the foundations which Williamson laid. In alluding to the controversies in which he bore so vigorous a part, Williamson spoke of the conflict as virtually over, though still reflected, "in the ground-swell of a stormy past." Now that twenty years have elapsed we are able to recognise with no little satisfaction that his views are firmly established, and that the debt which we owe to his able interpretation of the relics of Palæozoic plant-life is universally acknowledged. Williamson's labours demonstrated the possibilities of microscopical methods in the investigation of Carboniferous plants; but at the time of publication his results did not receive that attention which their importance merited, and it is only in recent years that botanists have been induced to admit the necessity of extending their observations to the buried treasures of bygone ages. We have been slow to realise the truth of the following statement, which I quote from an able article on Darwinism in the *Edinburgh Review* for October of last year: "The recognition of the fact that in every detail the present is built on the past has invested the latter with a new title to respect, and given a fresh impulse to the study of its history." The anatomical investigation of extinct types of vegetation has done more than any other branch of botanical science in guiding us along the paths of plant-evolution during the earlier periods of the earth's history.

I cannot conclude this brief reference to Williamson's work without an expression of gratitude for the help and encouragement with which he initiated me into the methods of palæobotanical research.

FLORAS OF THE PAST: THEIR COMPOSITION AND DISTRIBUTION.

Introduction.

It is by no means easy to make choice of a subject for a presidential address. There is the possibility—theoretical rather than actual—of a retrospective survey of modern developments in the botanical world, and the opportunity is a favourable one for passing in review recent progress in that department of the science which appeals more especially to oneself. In place of adopting either of these alternatives, I decided to deal in some detail with a subject which, it must be frankly admitted, is too extensive to be presented adequately in a single address. My aim is to put before you one aspect of palæobotany which has not received its due share of attention: I mean the geographical distribution of the floras of the past. In grappling with this subject one lays oneself open to the charge of attempting the impossible—a not unusual characteristic of British Association addresses. I recognise the futility of expecting conclusions of fundamental importance from such an incomplete examination of the available evidence as I have been able to undertake; but a hasty sketch may serve to indicate the impressions likely to be conveyed by a more elaborate picture.

One difficulty that meets us at the outset in approaching the study of plant distribution is that of synonymy. "The naturalist," as Sir Joseph Hooker wrote in his "Introductory Essay to the Flora of New Zealand," "has to seek truth amid errors of observation and judgment and the resulting chaos of synonymy which has been accumulated by thoughtless aspirants to the questionable honour of being the first to name a species." Endless confusion is caused by the use of different generic and specific names for plants that are in all probability identical, or at least very closely allied. Worthless fossils are frequently designated by a generic and specific title: an author lightly selects a new name for a miserable fragment of a fossil fern-frond without pausing to consider whether his record is worthy of acceptance at the hands of the botanical palæographer.

An enthusiastic specialist is apt to exaggerate the value of his material, and to forget that lists of plants should be based on evidence that can be used with confidence in investigations involving a comparative treatment of the floras of the world. As Darwin said in the "Origin of Species": "It is notorious on what excessively slight differences many palæontologists have founded their species; and they do this the more readily if the specimens come from different sub-stages of the same formation." It would occupy too much time to refer to the various dangers that beset the path of the trustful student, who makes use of published lists of local floras in generalising on questions of geographical distribution during the different eras of the past. Such practices as the naming of undeterminable fragments of leaves or twigs, the frequent use of recent generic names for fossil specimens that afford no trustworthy clue as to affinity, belong to the class of offences that might be easily guarded against; there are, however, other obstacles that we cannot expect to remove, but which we can take pains to avoid. An author in naming a fossil plant may select one of several generic names, any of which might be used with equal propriety; individual preferences assert themselves above considerations as to the importance of a uniform nomenclature. The personal element often plays too prominent a part. To quote a sentence from a non-scientific writer: "The child looks straight upon Nature as she is, while a man sees her reflected in a mirror, and his own figure can hardly help coming into the foreground."

In endeavouring to take a comprehensive survey of the records of plant-life, we should aim at a wider view of the limits of species and look for evidence of close relationship rather than for slight differences, which might justify the adoption of a distinctive name. Our object, in short, is not only to reduce to a common language the diverse designations founded on personal idiosyncrasies, but to group closely allied forms under one central type. We must boldly class together plants that we believe to be nearly allied, and resist the undue influence of considerations based on supposed specific distinctions.

The imperfection of the Geological record was spoken of by one of England's greatest geologists, in a criticism of the "Origin of Species," as "the inflated cushion on which you try to bolster up the defects of your hypothesis." On the other hand, Darwin wrote, in 1861: "I find, to my astonishment and joy, that such good men as Ramsay, Jukes, Geikie, and one older worker, Lyell, do not think that I have in the least exaggerated the imperfection of the record." No one in the least familiar with the conditions under which relics of vegetation are likely to have been preserved can for a moment doubt the truth of Darwin's words: "The crust of the earth, with its embedded remains, must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals."

As a preliminary consideration, we must decide upon the most convenient means of expressing the facts of geographical distribution in a concise form. The recognised botanical regions of the world do not serve our purpose; we are not concerned with the present position of mountain-chains or wide-stretching plains that constitute natural boundaries between one existing flora and another, but simply with the relative geographical position of localities from which records of ancient floras have been obtained. In the accompanying map I have divided the surface of the earth into six belts, from west to east. The most northerly or *Arctic Belt* includes the existing land-areas as far south as latitude 60°, comprising—1, Northern Canada; 2, Greenland and Iceland; 3, Northern Europe; 4, Bear Island and Spitzbergen; 5, Franz Josef's Land; 6, Northern Asia. The *North Temperate Belt*, extending from latitude 60° to 40°, includes—7, South Canada and the northern United States; 8, Central and Southern Europe; 9, Central Asia. The *North Subtropical Belt* comprises the land between latitude 40° and the Tropic of Cancer, including—10, the Southern States of North America; 11, Northern Africa, part of Arabia and Persia; 12, Thibet and part of China; 13, Japan. The *Tropical Belt*, embracing the land-areas between the Tropics of Cancer and Capricorn, includes—14, Central America and the northern part of South America; 15, Central Africa and

Madagascar; 16, India, the Malay Archipelago, and Northern Australia. The *South Subtropical Belt*, extending from the Tropic of Capricorn to latitude 40° south, includes —17, Central South America; 18, South Africa; 19, Central and Southern Australia. The *South Temperate Belt* includes—20, the extreme south of South America; 21, Tasmania; 22, New Zealand.

Pre-Devonian Floras.

The scanty records from pre-Devonian rocks afford but little information as to the nature of the vegetation that existed during the period in which were deposited the Cambrian, Ordovician, and Silurian strata that now form the greater portion of the Welsh and Cumberland hills. We must wait for further discoveries before attempting to give more than the barest outline of the plant-life of these remote epochs. Our knowledge of the plant-world which existed during the Silurian period is far too meagre to justify any statement as to geographical distribution. Of the few records of supposed Silurian plants, several have been shown to be unsatisfactory, and the nature of others is too uncertain to admit of accurate identification. The Lepidodendron-like fossil from the Clinton limestone of Silurian age in Ohio, described by Claypole in 1878 as Glyptodendron, has been referred by a later writer to a Cephalopod. Stur's Bohemian plants, described in 1881, are too imperfect to afford any information of botanical value; while the ferns and lepidodendroid plants recently recorded by Potonié from the Hartz Mountains are more likely to be of Devonian than Silurian age.

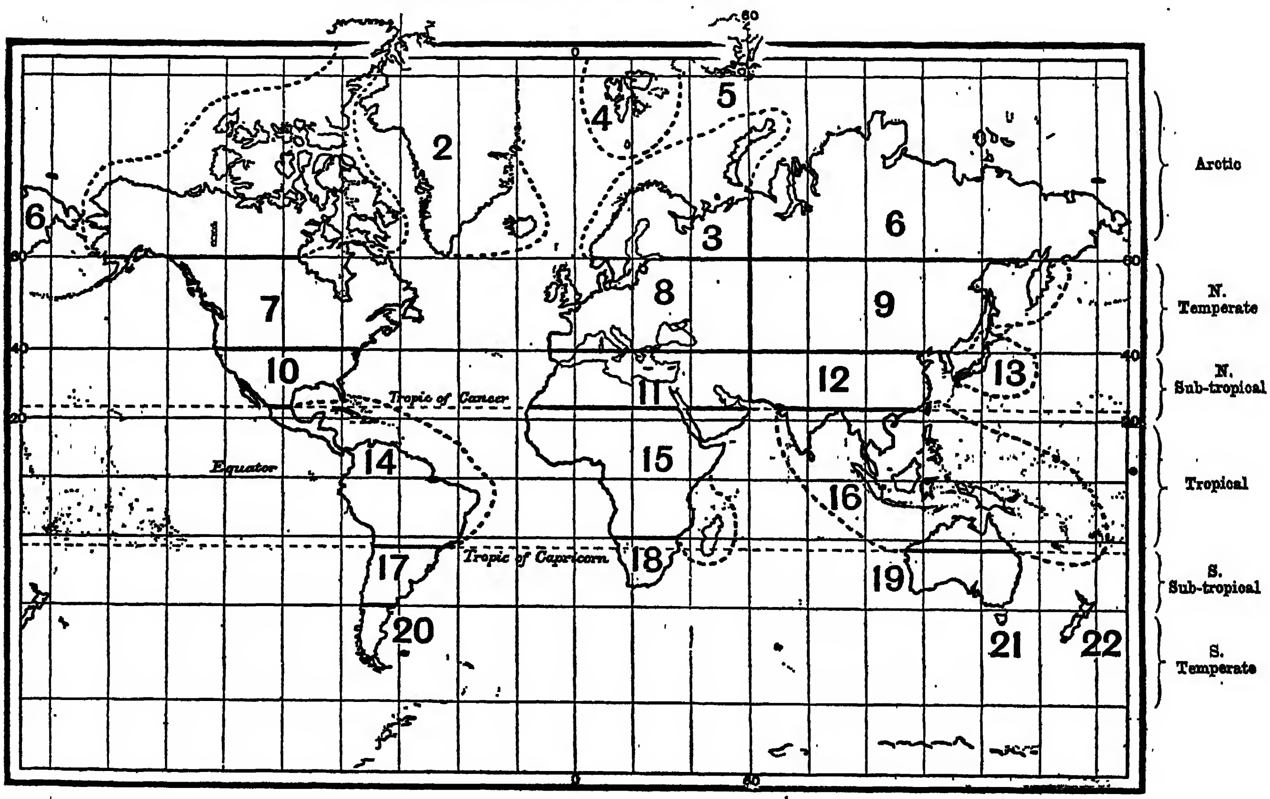
The genus Nematophycus, originally described by Dawson as Prototaxites, and afterwards referred by Carruthers to the Algæ, constitutes the most satisfactory example of a Silurian plant. This genus, which has fortunately been preserved in such a manner as to admit of minute microscopical examination, represents a widely spread algal type in Silurian and Devonian seas. It has been found in Silurian strata in Wales, Shropshire, and New Brunswick; also in Devonian rocks of Eastern Canada, New York, Ohio, and North-West Germany. The tubular elements composing the stems of some species of Nematophycus —which reached a diameter of 2 or 3 feet—exhibit a regular variation in width, giving the appearance of concentric rings of growth, as in the stems of the tree-like Lessonia, an existing genus of Antarctic seaweeds. This structural feature presents an impressive image in stone of a plant's rhythmical response to some periodically recurring conditions of growth in the waters of Palæozoic seas.

Devonian and Lower Carboniferous Floras.

The earliest plants that have been found in sufficient number, and in a state of preservation which renders their identification possible, are those from Devonian rocks. From Bear Island, a small remnant of land situated within the Arctic circle, the late Prof. Heer described several Devonian plants; and more recently Prof. Nathorst, of Stockholm, has given a full account of this interesting and comparatively rich flora. The relics of plant-life preserved in this Arctic island carry us back through countless ages to a time when a luxuriant vegetation flourished in a region now occupied by ice-bound land and polar seas. As Edward Fitzgerald said, in speaking of his enjoyment of some geological book: "This vision of time is in itself more wonderful than all the conceptions of Dante and Milton." Devonian plants have been described by Feistmantel, Etheridge, and others from Australia; and the well-known Kiltorkan grits of Ireland have supplied a few well-preserved impressions of the oldest land-plants disinterred from British rocks.

As my aim is to sketch in broad outline the general facies of the vegetation which flourished at different stages in the earth's history, rather than to undertake a critical examination of the evidence as to the precise geological age of the plant-bearing beds, I propose to treat of Devonian and Lower Carboniferous floras as constituting one phase in the evolu-

MAP I.—The Earth's Surface divided into Areas (1–22) for convenience in recording the Geographical Distribution of Fossil Plants.



tion of the plant-world. In speaking of the plants of the Devonian and Lower Carboniferous or Culm phase, it is not assumed that the specimens entombed in the snow-covered cliffs of Bear Island were actually contemporaneous with those found in rocks of the same geological period in the Southern hemisphere. The Bear Island rocks are, in the language which Huxley taught us to use, homotaxial with certain Devonian plant-bearing strata in other parts of the world; they occupy the same relative position in the geological series.

Homotaxy by no means implies contemporaneity; indeed, the late Edward Forbes maintained that similarity of organic contents of distant formations should be accepted as *prima facie* evidence of a difference in age.

What do we know as to the composition of the floras that flourished in the later stages of the Devonian and in the latter part of the Carboniferous era? The following list, which is by no means exhaustive, represents some of the more important generic types which may be very briefly described:—

1. EQUISETALES.
   Archaeocalamites.

2. SPHENOPHYLLALES.
   Sphenophyllum.
   Cheirostrobus.
   [*Pseudobornia?*]

3. LYCOPODIALES.
   Lepidodendron.
   Bothrodendron.

4. FILICALES.
   Archaeopteris.
   Adiantites.
   Rhodea.
   Cardiopteris.
   Todeopsis.
   Cephalotheca.
   Rhacopteris.

5. CYCADOFILICES.
   Calamopitys.
   Heterangium.
   Lyginodendron.

6. GYMNOSPERMÆ.
   (CORDAITALES).
   Cordaites.
   Pitys.

In Archæocalamites we have the oldest example of an undoubted Equisetaceous genus. The structure of its comparatively thick and woody stem is practically identical with that of our common British type of Calamites, one of the most abundant of the Coal period genera, while the strobilus differed in no essential feature from that of a modern Horsetail. The genus Cheirostrobus, founded in 1897 by Dr. D. H. Scott on a single specimen of a petrified cone discovered in the rich volcanic beds of Lower Carboniferous age at Pettycur on the shores of the Firth of Forth, affords a striking illustration of a Palæozoic plant exhibiting a structure far more complex than that of any known type among existing Vascular Cryptogams. As Scott clearly shows in his admirable memoir, Cheirostrobus is a synthetic or compound genus, one of the numerous extinct types brought to light by the anatomical investigation of fossil plants, from which we have learnt more about the inter-relations of existing classes than we could ever hope to discover from the examination of recent species.

In this Scotch cone, about 3·5 cm. in diameter, we recognise Equisetaceous and Lycopodinous characters combined with morphological features typical of the extinct genus Sphenophyllum. Some specimens of vegetative stems described by Nathorst from Bear Island under the name Pseudobornia—characterised by their whorled leaves with fimbriate blades borne on nodal regions separated by long internodes—may, as Scott has suggested, represent the branches of the tree of which Cheirostrobus was the cone. Both Devonian and Culm rocks have furnished many examples of Lycopodinous plants. The genus Bothrodendron, closely allied in habit to Lepidodendron, has been recorded from Bear Island, Ireland, and Australia, and the cuticles of a Lower Carboniferous species form the greater portion of the so-called paper-coal of Tula in Russia. Lepidodendron itself had already attained to the size of a forest tree, with anatomical features precisely similar to those of the succeeding Coal period species.

Our knowledge of the ferns is not very extensive. The genus Archæopteris from Ireland, Belgium, Bear Island, and North America has always been regarded as a fern, but we must admit the impossibility of accurately determining its systematic position until we possess a fuller knowledge of the reproductive organs and of its anatomical structure. Similarly the genera Rhacopteris, Adiantites, and Rhodea, with other characteristic members of the Lower Carboniferous vegetation, may be provisionally retained among the oldest known ferns. The genus Cardiopteris—a plant with large oblong or orbicular pinnules borne in two rows on a stout rachis—is known only in a sterile condition, and it is quite as likely that its reproductive organs may have been of the Gymnospermous as of the Filicinean type.

Renault has described under the name Todeopsis some petrified sporangia which appear to be practically identical with those of existing Osmundaceæ, and a new Devonian genus Cephalotheca has been instituted by Nathorst for fertile specimens of a strange type of plant which he refers to the Marattiaceæ. Of much greater importance than the sterile fern-like fronds, which cannot be assigned with confidence to a definite position, are the petrified remains of stems and leaves of such plants as Heterangium, Lyginodendron, Calamopitys, and others which demonstrate the existence of a class of synthetic genera combining Filicinean and Cycadean characters. These plants are of exceptional interest as showing beyond doubt that Ferns and Cycads trace their descent from a common ancestry. Some of the supposed ferns from Lower Carboniferous rocks are known to have been fronds borne on stems with the structure of cycads, and we have good reason for believing that some at least of the gymnospermous seeds of Palæozoic age are those of plants of which the outward form was more fern-like than cycadean. The announcement made a few months ago by Prof. Oliver and Dr. Scott that they had obtained good evidence as to the connection of the gymnospermous seed known as Lagenostoma with the genus Lyginodendron is one of the most important contributions to botany published in recent years; if, as I firmly believe, the evidence adduced is convincing, it gives satisfactory confirmation to suspicions that previous discoveries led us to entertain. The fact demonstrated is this: the genus Lyginodendron, a plant known to have existed during the greater part of the Carboniferous epoch, possessed a stem of which the primary structure was almost identical with that which characterises some recent species of Osmundaceæ, while the secondary wood produced by the activity of a cambium is hardly distinguishable from the corresponding tissue in the stem of a recent cycad. The fronds were those of a fern, both in the anatomy of their vascular tissue and in their external form; so far, therefore, as the vegetative characters are concerned, we have a combination of ferns and cycads. We still lack complete knowledge of the nature of the reproductive organs, but it seems clear that Lyginodendron bore seeds constructed on the Gymnospermous plan, but characterised by an architectural complexity far beyond that represented in the seeds of any modern Conifer or Cycad.

In such genera of Gymnosperms as Cordaites, Pitys, and others, we have examples of forest trees possessing wood almost identical with that of existing species of Araucaria, but distinguished by certain peculiarities which point to a relationship with members of the Cycadofilices, and suggest that Conifers as well as Cycads may have sprung from a filicinean stock.

These waifs and strays from the vegetation of an era incredibly remote, when strange amphibians were lords of the animal world, afford, as Newberry expresses it, "fascinating glimpses of the head of the column of terrestrial vegetation that has marched across the earth's stage during the different geological ages."

Two facts stand out prominently as the result of a general survey of what are practically the oldest records of plant-life. One is the abundance of types which cannot be accommodated in our existing classification founded solely on living plants.

The Devonian and Lower Carboniferous plants lead us away from the present along converging lines of evolution to a remote stage in the history of life; they bring us face to face with proofs of common origins, which enable us to recognise community of descent in existing groups between which a direct alliance is either dimly suggested or absolutely unsuspected if we confine our investigations to modern forms. We recognise, moreover, in such a plant as Archæocalamites an ancestor from which we may derive in a direct line the existing members of the Equisetales. In other types, by far the greater number, we see striking examples of Nature's many failures, which, after reaching an extraordinary com-

plexity of organisation, gave place to other products of evolution and left no direct descendants.

Another fact that seems to stand out clearly is the almost world-wide distribution of several characteristic Lower Carboniferous plants. The accompanying table (Table I.), based on the artificial divisions marked out on the map, to which reference has already been made, shows how widely some of the plants had migrated from an unknown centre far back in a still more remote age. We are, as yet, unable to follow these Devonian plants to an earlier stage in their evolution. We are left in amazement at their specialised structure and extended geographical distribution, without the means of perusing the opening chapters of their history.

I. *Devonian and Lower Carboniferous Floras.—Table showing the Geographical Distribution of a few Characteristic Genera.*

Characteristic Types	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
EQUISETALES																						
Archaeocalamites radiatus				×			×	×									×		×			
Calamites								×														
SPHENOPHYLLALES																						
Sphenophyllum				×				×														
Cheirostrobus								×														
LYCOPODIALES																						
Lepidodendron				×				×									×	×	×			
Bothrodendron				×			×	×											×			
FILICALES (?)																						
Archaeopteris				×			×	×											×			
Adiantites				×			×	×														
Rhacopteris								×									×		×			
Rhodea				×				×														
Cardiopteris				×				×														
CYCADOFILICES																						
Lyginodendron								×														
Heterangium								×														
CORDAITALES																						
Cordaites							×					×					×					

Upper Carboniferous (Coal-measures) and Permian Floras.

From the Lower Carboniferous formation we pass on to the wealth of material afforded by the Upper Carboniferous and Permian rocks. From the point of view of both botanists and geologists, the fossil plants obtained from the beds associated with the coal are of greater interest and importance than those of any other geological period. By a fortunate accident our investigations are not restricted to the examination of carbonaceous impressions and sandstone casts left by the stems and leaves of the Coal-period plants. By means of thin sections cut from the calcareous nodules of the coal-seams of Yorkshire and Lancashire, and from the silicified pebbles of France and Saxony, it is possible to make anatomical investigations of the coal-forest trees with as much accuracy as that with which we can examine sections of recent plants. The differences between the vegetation that witnessed the close of the Carboniferous era and that which flourished during the opening stages of the succeeding Permian epoch are comparatively slight. It has been demonstrated by Grand'Eury, Kidston, Zeiller, Potonié, and others, that it is possible both to separate the floras of the Coal-measures from those of Lower Permian age, and to use the plant species as trustworthy guides to the smaller subdivisions of the Coal-measures; but apart from these minor differences, the general facies of the vegetation remained fairly constant during the Upper Carboniferous and Lower Permian periods.

The vast forests of the Coal age occupied an extensive area of land on the site of the present United States of North America, stretching across Europe into Eastern Asia; under the shade of their trees lived "the stupid, salamander-like Labyrinthodonts, which pottered with much belly and little leg, like Falstaff in his old age." The plants of these Palæozoic forests seem to be revivified, as we subject their petrified fragments to microscopical examination. Robert Louis Stevenson has referred to a venerable oak, which has been growing since the Reformation and is yet a living thing liable to sickness and death, as a speaking lesson in history. How much more impressive is the conception of age suggested by the contemplation of a group of Palæozoic tree-stumps exposed in a Carboniferous quarry and rooted where they grew! An examination of their minute anatomy carries us beyond the mere knowledge of the internal architecture of their stems, leaves, and seeds; it brings us into contact with the actual working of their complex machinery. As we look at the stomata on the lamina of a leaf of one of those strange trees, and recognise a type of structure in the mesophyll-tissues which has been rendered familiar by its occurrence in modern leaves, it requires but little imagination to see the green blade spreading its surface to the light to obtain a supply of solar energy with which to extract carbon from the air. We can almost hear the murmur of plant-life and the sighing of the branches in the wind as the sap courses through the wood, and the leaves build up material from the products of earth and air; products that are to be sealed up by subsequent geological changes, until after the lapse of countless ages the store of energy accumulated in coal is dissipated through the agency of man.

The minute structure of the wood of the Calamites, Lycopods, and other trees, agrees so closely with that of existing types that we are forced to conclude that these Palæozoic plants had already solved the problem of raising a column of water more than 100 feet in height. The arrangement of the strengthening or mechanical tissues in the long flat leaves of Cordaites is an exact counterpart of that which we find in modern leaves of similar form. The method of disposition of supporting strands in such manner as to secure the maximum effect with the least expenditure of material was as much an axiom in plant

architecture in the days of the coal-forests as it is now one of the recognised rules in the engineer's craft.

We need not pause to discuss the various opinions that have been expressed as to the conditions under which the forests grew; we may adopt Neumayr's view, and recognise a modern parallel in the moors of the sub-arctic zone, or find a close resemblance in the dismal swamp of North America. There is also the view expressed many years ago by Binney and warmly advocated by Darwin, that some at least of the Coal-period trees grew in salt-marshes, an opinion which receives support from several structural features suggestive of xerophytic characters recognised in the tissues of Palæozoic plants.

Time does not admit of more than the most cursory glance at the leading types of the Permo-Carboniferous floras. The general character of the preceding vegetation is retained with numerous additions. Archæocalamites is replaced by a host of representatives of the genus Calamites, an Equisetaceous type with stout woody stems and several forms of cones of greater complexity than those of modern Horsetails. Side by side with the Calamites there appear to have existed plants which, from their still closer agreement with Equisetum, have been described by Zeiller, Kidston, and others as species of Equisetites. The genus Sphenophyllum, a solitary type of an extinct family, was represented by several forms which, like the Galium of our hedgerows, may have supported their slender branches against the stems of stronger plants. Lycopods, with trunks as thick and tall as forest trees, were among the most vigorous members of the later Palæozoic forests. Although recent research has shown that several of the supposed ferns must be assigned to the Cycad-fern alliance, there can be no doubt that true ferns had reached an advanced state of evolution during the Permo-Carboniferous epoch. The abundance of petrified stems of the genus Psaronius, of which the nearest living representatives are probably to be found among the tropical Marattiaceæ, demonstrates the existence of true ferns. Others had more slender stems which clambered over the trunks of stouter trees, while some grew in the shade of Lepidodendron and Cordaites. The most striking fact as regards the Permo-Carboniferous ferns is the abundance of fertile fronds bearing sporangia which exhibit a more or less close agreement with those of the few surviving genera of Marattiaceæ. The more familiar type of sporangium met with in our existing fern-vegetation is also represented, and we have recently become familiar with several genera bearing sporangia exhibiting a close resemblance to those of modern Gleicheniaceæ, Schizæaceæ, and Osmundaceæ. The sporangial characteristics of the different families of living ferns are many of them to be found among Palæozoic types, but there is a frequent commingling of structural features showing that the ferns had not as yet become differentiated into so many or such distinct families as have since been evolved.

Prominent among the Gymnosperms of the Palæozoic forests must have been the genus Cordaites: tall handsome trees, with long strap-shaped leaves, recalling on a large scale those of the kauri pine of New Zealand. This genus, which has been made the type of a distinct group of Gymnosperms, combined the anatomy of an Araucaria with reproductive organs more nearly allied to the flowers of Cycads, and exhibiting points of resemblance with those of the Maidenhair-tree. It is not until the later stages of the Permo-Carboniferous epoch that more definite coniferous types make their appearance. The genus Walchia, in habit almost identical with *Araucaria excelsa*, the Norfolk Island pine, with Ulmannia and Voltzia, are characteristic members of the vegetation belonging to the later phase of the Permo-Carboniferous era. The Maidenhair-tree of the far East, one of the most venerable survivors in our modern vegetation, is foreshadowed in certain features exhibited by Cordaites and, as regards the form of its leaves, by Psygmophyllum, Wittleseya, and other genera. Psygmophyllum is known to have existed in Spitzbergen in the preceding Culm epoch, and Wittleseya occurs in Canadian strata correlated with our Millstone Grit. Leaves have been found in Permian rocks of Russia, Siberia, Western and Central Europe, referred to the genus Baiera, a typical Mesozoic type closely allied to Ginkgo. In the upper Coal-measures and lower Permian rocks a few pinnate fronds have been discovered, such as Sphenozamites, from the Permian of France, Pterophyllum from France and Russia, and Plagiozamites from the Permian of Alsace, which bear a striking likeness to modern Cycadean leaves. Throughout the Permo-Carboniferous era the Cycadofilices formed a dominant group; Lyginodendron, Medullosa, Poroxylon, and many other genera flourished in abundance as vigorous members of an ancient class which belongs exclusively to the past.

One distinctive characteristic of the vegetation of later Permo-Carboniferous days is the occurrence of the Cycad-like fronds already referred to; also the appearance of Voltzia and other conifers with species of Equisetites, pioneer genera of a succeeding era that constitute connecting links between the Palæozoic and Mesozoic floras.

What we may call the typical vegetation of the Coal-measures, which continued, with comparatively minor changes, into the succeeding era, flourished over a wide area in the northern hemisphere, suggesting, as White points out, an almost incredible uniformity of climate. The same type of vegetation extended as far south as the Zambesi in Africa, and to the vast coal-fields of China; it possibly existed also in high northern latitudes, but, since Heer's record of Cordaites in Novaya Zemlya in 1878, no further traces of arctic Permo-Carboniferous plants have been found. Calamites, Lepidodendron (with its near relative Sigillaria), Ferns, Cycadofilices, Cordaites, and other Gymnosperms, constitute the most familiar types. We have already noticed the existence in the southern hemisphere of Lower Carboniferous and Devonian genera identical with plants found in rocks of corresponding age within the Arctic circle. This agreement between the northern and southern floras was, however, not maintained in the later stages of the Palæozoic epoch. Australian plant-bearing strata homotaxial with Permo-Carboniferous rocks of Europe, have so far afforded no examples of Sigillaria, Lepidodendron, or of several other characteristic northern forms; in place of these genera we find an enormous abundance of a fern known as Glossopteris, a type which must have monopolised wide areas, suggesting a comparison with the green carpet of bracken that stretches as a continuous sheet over an English moor. With Glossopteris was associated a fern bearing similar leaves, known as Gangamopteris, and with these grew Schizoneura and Phyllotheca, members of the Equisetales. In addition to these genera there are others which bear a close resemblance to northern hemisphere types, such as Noeggerathiopsis, a member of the Cordaitales, and several species of Sphenopteris. Similarly, in many parts of India, Glossopteris has been found in extraordinary abundance in the same company with which it occurs in Australia. In South Africa an identical flora is met with which extends to the Argentine and to other regions of South America. A few members of this southern flora have been recorded from Borneo, and the genus Glossopteris is said to occur in New Zealand, but the latter statement has been called in question and requires confirmation. It is clear that from South America, through South Africa and India to Australia, there existed a vegetation of uniform character which flourished over a vast southern continent at approximately the same period as that which, in the northern hemisphere and in China, witnessed the growth of the forests the trees of which formed the source of our coal-supply.

Since attention was drawn by Dr. Blanford and other writers to the facts of plant-distribution revealed by a study of the later Palæozoic floras, it has been generally admitted that during the Permo-Carboniferous era there existed two fairly well-marked botanical provinces. The more familiar and far richer flora occupied a province stretching from the western States of North America across Europe into China and reaching as far as the Zambesi; the other province was occupied by a less varied assemblage of plants, characterised by the abundance of Glossopteris, Gangamopteris, Neuropteridium, Noeggerathiopsis, Schizoneura, and other genera, stretching from South America through India to Australia.

Two questions at once suggest themselves: first, were these two botanical provinces defined by well-marked boundaries, or did they dovetail into one another at certain points? Secondly, is there any probable explanation of this

difference between northern and southern floras, a feature not shown either by the preceding Devonian and Lower Carboniferous or by the succeeding Lower Mesozoic floras?

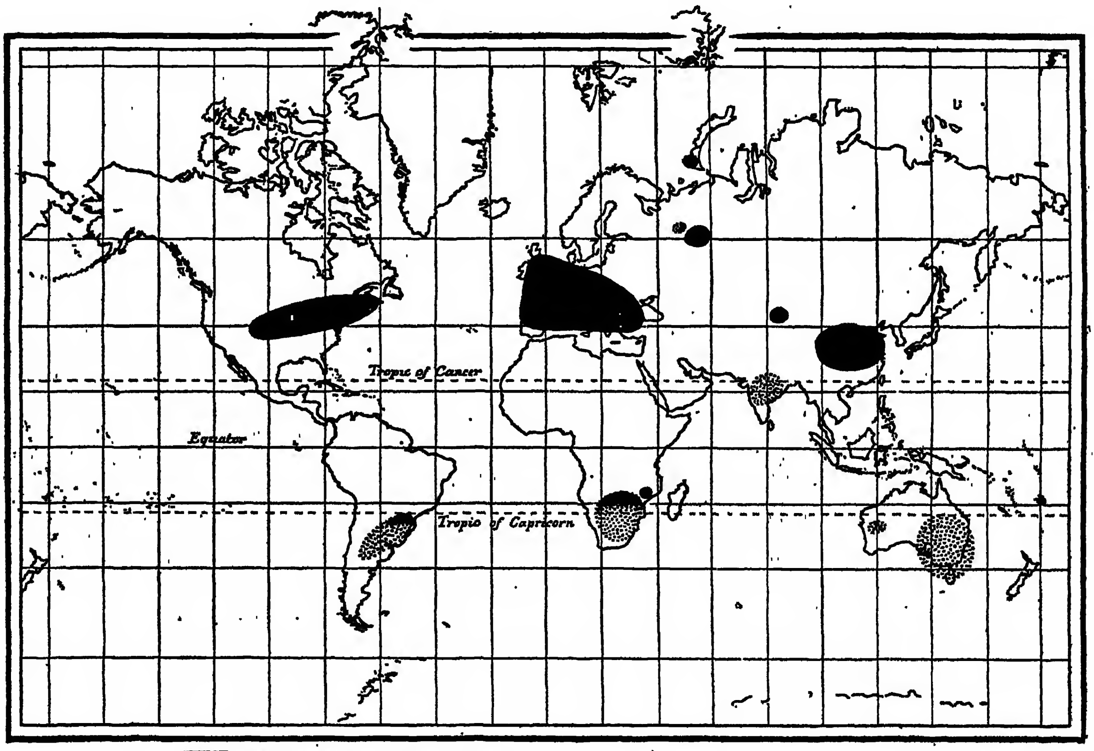
In Brazil, Prof. Zeiller has recorded the occurrence of a flora including Lepidophloios, a well-known European member of the Lycopods, associated with such characteristic southern types as Gangamopteris and Noeggerathiopsis. Similarly from the Transvaal a European species of Sigillaria, with a Lepidodendroid plant, and another northern genus, Psygmophyllum, have been found in beds containing Glossopteris, Gangamopteris, Noeggerathiopsis, Neuropteridium, and other members of the so-called Glossopteris flora. In India, the Glossopteris flora exhibits an entire absence of Lepidodendron, Calamites, Sigillaria, and other common northern genera, while Sphenophyllum is represented by a single species. The Australian Permo-Carboniferous flora is also characterised by the absence of the great majority of the northern types. Until a few years ago the genus Glossopteris had not been discovered in Europe, but in 1897 Prof. Amalitzky recorded the occurrence of this genus in association with Gangamopteris in Permian strata in northern Russia.

We see, then, that in Brazil and South Africa the Glossopteris flora and the northern flora overlapped, but the former was the dominant partner. On the other hand, in rocks belonging to a somewhat higher horizon in Russia, we meet with a northern extension of the Glossopteris flora. Map II. serves better than a detailed description to illustrate the geographical distribution of these two types of vegetation in the Permo-Carboniferous era.

There is little doubt that the differences between the flora of the southern continent, that existed towards the close of the Carboniferous and during the succeeding Permian period, and that which flourished farther north have in some respects been exaggerated; geographical separation has played too conspicuous a part in influencing botanical nomenclature. Granting the existence of identical genera or representative types, there remains a striking difference between the two provinces into which the Permo-Carboniferous vegetation was divided. As regards an explanation of this fact, we can only hazard a guess; as Dr. Blanford and others have pointed out, there is a probable solution to hand. Briefly stated, the Upper Palæozoic plant-bearing strata of India, South America, Australia, and South Africa are in close association with boulder-beds of considerable extent. In some places, as for example in India and Australia, the boulder-beds rest on rocks bearing unmistakable signs of the grinding action of ice. There can be no reasonable doubt that the huge continental area of which India, South Africa, parts of South America, and Australia remain as comparatively insignificant remnants, was exposed to climatal conditions favourable to the accumulation of snow and to the formation of glaciers. One possible explanation, therefore, of the existence of a distinct vegetation in the southern area is that the climate was such as to render impossible the existence of those coal-forest plants that exhibited so vigorous a development in northern latitudes. There is, moreover, another consideration, and that is the effect on the vegetation of an enormous continental mass; in North America and Europe it is probable that the forests grew on low-lying land penetrated by lagoons and in part submerged under shallow brackish water, a disposition of land and sea very different from that in the so-called Gondwana Land of the South. Possibly the apparently uniform vegetation of the Devonian and Lower Carboniferous period was unable, through stress of climatal conditions, to prolong its existence in the southern area, while in the north it continued to flourish, and as the evolution of new types proceeded in rapid succession it was not slow to colonise new areas stretching in South America and South Africa to the confines of the Glossopteris flora.

There seems good reason for assuming that the Glossopteris flora originated in the South and before the close of the Permian period, as well as in the succeeding Triassic era, pushed northward over a portion of the area previously occupied by the northern flora. This northward extension

MAP II.—Permo-Carboniferous Floras.



= *Glossopteris* (Southern Flora).
= Northern Flora.

is shown by the existence of Glossopteris in Upper Permian rocks of Russia, by the occurrence of several southern types in plant-bearing beds of the Altai mountains, and by the existence in Western Europe during the early stages of the Triassic era of such southern genera as Neuropteridium and Schizoneura.

Triassic, Jurassic, and Wealden Floras.

It is unfortunate that the records of plant-life towards the close of the Palæozoic and during the succeeding Triassic period are very fragmentary; the documents are few in number, and instead of the fairly continuous chapters in which the records of the Coal age have been preserved, we have to be content with a few blurred pages. During the Triassic period the vegetation of the world gradually changed its character; the balance of power was shifted from the Vascular Cryptogams, the dominant group of the Palæozoic era, to the Gymnosperms. It is not until we pass up the geologic series as far as the Rhætic formation, that we come to palæobotanical records at all comparable in their completeness with those of the Permo-Carboniferous era; but before considering the Rhætic vegetation we must glance at such scattered relics as remain of the vegetation belonging to the period of transition between the Palæozoic and Mesozoic facies. It is regrettable that this transitional period is unusually poor in documentary evidence that might throw light on the gradual change in the facies of Palæozoic vegetation. The new order, when once established, persisted for many succeeding ages without undergoing any essential alteration.

One of the few floras of early Triassic age of which satisfactory relics have been preserved is that described in 1844 by Schimper and Mougeot from the Bunter Sandstones of the Vosges. The genus Neuropteridium, a plant which may be a true fern, or possibly a surviving member of the Cycadofilices, is represented by a species which can hardly be distinguished from that which flourished in South America, South Africa, and India in the Permo-Carboniferous period. This genus and another southern type, Schizoneura, both of which are met with in the Triassic rocks of the Vosges, would seem to point to a northern migration of certain members of the Glossopteris flora, which took place at the close of the Palæozoic era. In the Lower Triassic flora Conifers are relatively more abundant than in the earlier periods; such genera as Albertia (resembling in its vegetative features some recent species of Araucaria), Voltzia (with cones that cannot be closely matched with those of any existing members of the Coniferæ), and other representatives of this class are common fossils. Lepidodendra have apparently ceased to exist; Sigillaria may be said to survive in one somewhat doubtful form, *Sigillaria oculina*. The genus Pleuromeia, which makes its appearance in Triassic rocks, is known only in the form of casts exhibiting a strong likeness to some Palæozoic Lycopods, and is perhaps more akin to Isoetes than to any other existing plant. The Calamites are now replaced by large Equisetaceous plants, which are best described as Horsetails with much thicker stems than those of their modern descendants.

From Recoaro in Northern Italy some of the Vosges genera have been recorded, and a few other European localities have furnished similar relics of a Triassic vegetation. Passing to the peninsula of India, we find the genus Glossopteris abundantly represented in strata which there is good reason for regarding as homotaxial with the European Trias, and the occurrence in the same beds of some other genera of Permo-Carboniferous age shows that the change in the character of the southern vegetation at the close of the Palæozoic era was much more gradual than in the north.

The comparative abundance of plant remains in the northern hemisphere in rocks belonging to the Rhætic formation, a series of sediments so named from their development in the Rhætian Alps, is in welcome contrast to the paucity of the records from the underlying Triassic strata. From Virginia and adjacent districts in the United States a rich flora has been described, which by some authors is assigned to the Keuper or Upper Triassic series, while others class it as Rhætic. A similar assemblage of plants is known also from the Lettenkohle beds of Austria which, as Stur has shown, clearly belong to the same period of vegetation as the American flora. We need not, however, concern ourselves with discussions as to the precise stratigraphical position of these American and European plant-beds, but may conveniently group together floras of Upper Triassic and Rhætic age since they exhibit but minor differences from one another. Plants of Upper Triassic or Rhætic age are known from Scania and Franconia in Europe, Virginia and elsewhere in North America, Honduras, Tonkin, Australia, South Africa, Chili, and other parts of the world.

The geographical distribution of plants of approximately Rhætic age is shown in the following table, No. II., on p. 563, which demonstrates an almost world-wide range of a vegetation of uniform character. The character of the plant-world is entirely different from that which we have described in speaking of the Palæozoic floras. Gymnosperms have ousted Vascular Cryptogams from their position of superiority; ferns, indeed, are still very abundant, but they have undergone many and striking changes, notably in the much smaller representation of the Marattiaceæ. The Palæozoic Lycopods and Calamites have gone, and in their place we have a wealth of Cycadean and Coniferous types. As we ascend to the Jurassic plant-beds the change in the vegetation is comparatively slight, and the same persistence of a well-marked type of vegetation extends into the Wealden period. It is a remarkable fact that after the Palæozoic floras had been replaced by those of the Mesozoic era, the vegetation maintained a striking uniformity of character, from the close of the Triassic up to the dawn of the Cretaceous era. This statement is open to misconception; I do not wish to convey the idea that a palæobotanist would be unable to discriminate between floras from Rhætic and Wealden rocks; but I wish to emphasise the fact that in spite of specific, and to a less extent of generic, peculiarities, which enable us to determine, within narrow limits, the age of a Mesozoic flora, the main features of the vegetation remained the same through a long succession of ages. The accompanying tables (Nos. III. and IV.) illustrate the geographical distribution of some of the leading types of Mesozoic plants during the Jurassic and Wealden periods, and demonstrate not only the striking differences between the Mesozoic and Palæozoic floras, but also the much greater uniformity in the vegetation of the world during the Secondary era than in the preceding Permo-Carboniferous epoch.

Mesozoic Floras.

It may be of interest to glance at some of the leading types of Mesozoic floras with the view of comparing them with their modern representatives. We are so familiar with the present position of the flowering plants in the vegetation of the world, that it is difficult for us to form a conception of a state of things in the history of the plant-kingdom in which Angiosperms had no part.

a. Conifers.

How may we describe the characteristic features of Rhætic and Jurassic floras? Gymnosperms, so far as we know, marked the highest level of plant-evolution. Conifers were abundant, but the majority were not members of that group to which the best known and most widely distributed modern forms belong.

A comparison of fossil and recent conifers is rendered difficult by the lack of satisfactory evidence as to the systematic position of many of the commoner types met with in Mesozoic rocks. There are, however, certain broad generalisations which we are justified in making; such genera as the Pines, Firs, Larches, and other members of the Abietineæ appear to have occupied a subordinate position during the Triassic and Jurassic eras; it is among the relics of Wealden and Lower Cretaceous floras that cones and vegetative shoots like those of recent Pines occur for the first time in a position of importance. There are several Mesozoic Conifers to which such artificial designations as Pagiophyllum, Brachyphyllum, and others have been assigned, which cannot be referred with certainty to a particular section of the Coniferæ; these forms, however, exhibit distinct indications of a close relationship with the Araucarieæ, represented in modern floras by Araucaria and Agathis. The abundance of cones in Jurassic strata showing the characteristic features of those of recent species of Araucaria affords trustworthy evidence as to the antiquity of the Araucarieæ and demonstrates their wide geographical distribution during the Mesozoic era. At the present day the Araucarieæ comprise the two genera Araucaria and

II. *Rhaetic Floras.—Geographical Distribution of a few Characteristic Types.*

Characteristic Types	Arctic						N. Temperate			N. Sub-tropical				Tropical			S Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7		9	10	11	12	13	14	15	16	17	18	19	20	21	22
EQUISETALES																						
Equisetites Muensteri ... / *Equisetites arenaceus* ...		×					×	×		×	×					×						
Schizoneura								×			×	×				×		×				
Phyllotheca											×								×		×	
FILICALES																						
Clathropteris ... ... / *Dictyophyllum*							×	×			×	×				×			×			
Laccopteris								×											×			
Todites		×					×	×			×	×				×			×		×	
Taeniopteris							×	×		×	×					×		×	×			
Thinnfeldia								×								×	×	×	×		×	
Sagenopteris							×	×											×		×	
CYCADOPHYTA																						
Cycadites							×	×								×						
Podozamites		×					×	×			×					×						
Otozamites								×		×	×			×		×						
Anomozamites								×			×			×		×						
Pterophyllum		×					×	×			×			×		×			×		×	
GINKGOALES																						
Baiera ... ... / *Ginkgo*		×					×	×			×							×	×		×	

III. *Jurassic Floras.—Geographical Distribution of Characteristic Types.*

Characteristic Types	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
EQUISETALES																						
Equisetites								×					×		×	×			×			
LYCOPODIALES																						
Lycopodites								×					×			×			×			
FILICALES																						
Cladophlebis denticulata							×	×	×	×			×			×			×			×
Coniopteris						×	×	×	×			×	×			×			×			
Dictyophyllum								×	×								×					
Klukia								×					×		×							
Laccopteris								×											×			
Matonidium							×	×														
Taeniopteris								×		×		×	×			×			×			×
Todites							×	×	×			×	×									
CYCADOPHYTA																						
Nilssonia						×		×	×			×	×			×						
Otozamites								×								×	×					
Podozamites						×	×	×	×	×		×	×			×			×			
Williamsonia							×	×				×				×						
GINKGOALES																						
Baiera / *Ginkgo*					×	×	×	×	×	×		×	×						×			
CONIFERALES																						
Araucarites								×								×			×			
Pagiophyllum							×	×		×		×			×	×						
Brachyphyllum								×							×	×	×		×			

IV. *Wealden Floras.—Geographical Distribution of Characteristic Types.*

Characteristic Types	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
EQUISETALES																						
Equisetites							×	×					×									
FILICALES																						
Onychiopsis		×					×	×					×					×	×			
Matonidium							×	×														
Cladophlebis		×					×	×					×					×	×			
Sphenopteris							×	×										×				×
Weichselia							×	×					×									
Taeniopteris		×		×			×	×										×				
Laccopteris								×														
Gleichenites			×					×														
GINKGOALES																						
Baiera / *Ginkgo* }		×		×	×		×	×														
CONIFERALES																						
Sphenolepidium		×					×	×														
Araucarites							×	×														
Pinites			×					×														
CYCADOPHYTA																						
Nilssonia								×					×					×				
Otozamites		×						×														
Zamites							×	×					×					×				
Bennettites							×	×														

Agathis, the former including ten species occurring in South America and Australia, and the latter comprising four species which flourish in the Malay Archipelago, New Zealand, the Philippines, North-East Australia, and elsewhere. Sir William Thiselton-Dyer pointed out, in a lecture on plant-distribution, delivered in 1878, that the genus Araucaria appears to have been extinct in a wild state north of the Equator since the Jurassic epoch. Additional confirmation of the important status of this section of the Coniferæ is afforded by the abundance of petrified wood exhibiting Araucarian features, in both Jurassic and Wealden rocks. There is good reason to believe that the well-known Whitby jet was formed by the alteration of blocks of Araucarian wood drifted from forest-clad slopes overlooking a Jurassic estuary that occupied the site of the moors and headlands of North-East Yorkshire. Among familiar Jurassic genera, mention must be made of the genus Brachyphyllum, including species referred by some authors to Athrotaxites, represented by fragments of leafy twigs and branches bearing a striking resemblance to those of the isolated Tasmanian genus Athrotaxis. Omitting further reference to the various indications afforded by a study of Mesozoic Conifers as to the former extension of many of the more isolated recent types, we may present in a tabular form an epitome of the past and present range of the Araucarieæ:—

b. *Cycads.*

One of the most striking features of the Mesozoic vegetation is the abundance and wide distribution of Cycadean plants. To-day the Cycads or Sago-Palms are represented by ten genera and about eighty species; they are plants which occupy a subordinate position in modern floras, and occur for the most part as solitary types in tropical latitudes, never growing together in sufficiently large numbers to constitute a dominant feature in the vegetation. Cycads have long attracted attention as exhibiting morphological features of considerable interest. During the last few years the work of Ikeno, Webber, and Lang has shown us that the pollen of Cycas, Zamia, Stangeria, and probably of the other recent genera, produce spirally ciliated motile spermatozoids, the type of male cell previously regarded as constituting one of the well-defined distinctions between the Vascular Cryptogams and the Seed-bearing plants. The study of Palæozoic plants has done even more to break down the artificial barrier between Cycads and Vascular Cryptogams, by demonstrating beyond all reasonable doubt that our modern Cycads represent a small group of survivals descended from ancestors common to themselves and the ferns. Cycadean plants must have been among the commonest members of Mesozoic floras. Before the end of the Palæozoic era there existed plants bearing pinnate fronds similar to those of recent species of Cycadaceæ, and

Geographical Distribution of Past and Present ARAUCARIEÆ.

Araucarieæ	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Araucarites [Rhætic → Cretaceous]							×	×								×	×	×	×			
Araucaria 10 species																	×		×			
Agathis 4 species																×			×			×

in succeeding ages the group rapidly increased in number and variety until, in the Jurassic and the early Cretaceous periods, the Cycads asserted their superiority as the leading type of vegetation. The majority of Mesozoic Cycadean fronds are assigned to artificial or form-genera as an indication of our ignorance of their reproductive organs, or of the anatomical structure of their stems. As Prof. Nathorst has recently suggested, it is convenient to speak of these Cycadean remains as belonging to the group Cycadophyta. On the other hand, we find numerous petrified stems bearing well-preserved reproductive organs which enable us to compare the extinct with the existing species. We are in possession of enough facts to justify the statement that the majority of Mesozoic Cycads bore reproductive organs which differed in important morphological characters from those of existing forms. The researches of Williamson, Carruthers, Solms-Laubach, Lignier, and others, have revealed the existence of a large group of Cycadean plants—known as the Bennettiteæ—almost identical in habit with modern sago-palms, but distinguished by the complexity of their reproductive shoots. The Bennettiteæ, originally founded on a petrified stem discovered more than fifty years ago in the Isle of Wight, and represented by another fossil which Carruthers made the type of a new genus, Williamsonia, in 1870, possessed a thick stem, clothed with an armour of persistent leaf-bases and bearing a crown of pinnate fronds, as in most modern Cycads; but their flowers, which were borne on lateral shoots, were more highly specialised than those of the true Cycads. While most of the Mesozoic Cycads were no doubt members of the Bennettiteæ, others appear to have possessed reproductive organs like those of recent species. The Bennettiteæ belong to that vast army of plants that succumbed in the struggle for existence æons before the dawn of the Recent period. The other section of the Cycadophyta, the Cycadaceæ, still lingers on as one of the select band the present insignificance of which constitutes a badge of ancient lineage, and a faint reflection of past supremacy.

The wealth of Cycadean vegetation during the latter part of the Jurassic and the earlier stages of the Cretaceous periods is admirably illustrated by the discovery in the Black Hills of North America, and in other districts of the United States of hundreds of silicified trunks of Cycadean plants. The first discovery of petrified Cycadean stems in America was made by Tyson in 1859, who found two specimens in the Potomac beds of Maryland; since then more than 700 trunks, remnants of a vast Cycadean forest, have been obtained from the Black Hills alone. The investigations of Mr. Wieland, of Yale, who has been engaged for some time on the examination of this rich material, have already revealed the fact that in some of the Bennettiteæ the male and female organs were borne in a single flower, the female portion having a structure identical with that previously described from European stems, while the male flowers bear a close resemblance to the fertile fronds of a Marattiaceous fern. We have watched the progress of Mr. Wieland's researches with keen interest and look forward to further important developments. With some of us, indeed, the feelings of the ideal student of science are in danger of being overshadowed by a sensation akin to envy and a desire to invade American territory.

c. *Ginkgoales.*

Before leaving the Gymnosperms a word must be said about another section—the Ginkgoales—represented by the Maidenhair-tree of China and Japan. *Ginkgo* (or *Salisburia*) *biloba* has almost, if not quite, ceased to exist in an absolutely wild state, but as a cultivated tree it has now become familiar both in America and Europe. The living Maidenhair-tree is in truth an anachronism, a solitary remnant that brings us into touch with a vanished world and appears as an alien among its modern associates. The abundance of fossil leaves, like those of *Ginkgo biloba*, and of other slightly different forms referred to the genus Baiera, associated not infrequently with remains of male and female flowers, demonstrates the ubiquitous character of the Ginkgoales during the Rhætic, Jurassic, and Wealden periods. In the Jurassic shales of the Yorkshire Coast, Ginkgo and Baiera leaves occur in plenty, some of them practically identical with those of the existing species. The abundance of fossil Ginkgoales in other parts of the world—in Australia, South Africa, South America, China, Japan, North America, Greenland, Franz Josef's Land, Siberia, and throughout Europe—demonstrates the former vigour of this class of plants of which but one member survives. This type of Gymnosperm is distinctly foreshadowed in the Palæozoic vegetation, and as recently as the Eocene period a species of Ginkgo, indistinguishable in the form of its leaves from the living Maidenhair-tree, flourished in Western Scotland.

The accompanying table of distribution shows how extensive was the range of the Ginkgoales in the Mesozoic era—both geographically and stratigraphically.

Geographical Distribution of the GINKGOALES.

Ginkgoales	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Ginkgo } *Baiera* } ... ... [Rhætic → Cretaceous]		×		×	×		×	×	×			×	×			×		×	×		×	
Ginkgo biloba												×	×									

d. *Ferns.*

Although many of the Mesozoic ferns are preserved only in the form of sterile fronds and are of little botanical interest, several examples of fertile leaves are known which it is possible to compare with modern types. The Polypodiaceæ, representing the dominant family of recent ferns, are met with in nearly all parts of the world and possess the attributes of a group of plants at the zenith of its prosperity. We may confidently state that so far as the somewhat meagre evidence allows us to form an opinion, this family occupied a subordinate position in the composition of Mesozoic floras. Polypodiaceous sporangia have been met with in Palæozoic rocks, and their existence during the Mesozoic period is not merely a justifiable assumption, but is demonstrated by the occurrence of undoubted species of Polypodiaceæ. It seems clear, however, that this family did not attain to a position of importance until the Mesozoic vegetation gave place to that which characterises the present period. The Osmundaceæ are now represented by five species of Todea and four of Osmunda; *Todea barbara* occurs in South Africa, Australia, Tasmania, and New Zealand, the other species are all filmy ferns and occur in New Zealand, New South Wales, New Caledonia, Samoa, and in a few other southern regions. The genus Osmunda has a wider range, occurring in Europe, Asia, North America, India, Japan, Southern China, Java, South Africa, and other parts of the world. During the Rhætic and Jurassic periods the Osmundaceæ flourished over the greater part of Europe; their remains have been recorded from England, Germany, Scandinavia, Russia, Poland, Siberia, and Greenland, also from North America, Persia, and China.

Similarly the Schizæaceæ, a family now represented by a few genera in India, North America, South America, Africa, Australia, Japan, China, and elsewhere, were among the more abundant ferns in the Jurassic vegetation. The Cyatheaceæ, a family that is now for the most part confined to the tropics, constituted another vigorous and widely

spread section in the Jurassic period; we find them in Jurassic rocks of Victoria, as well as in several regions in Europe, North America, and the Arctic regions.

The fertile fronds of many of the fossil Cyatheaceæ bear a striking resemblance to that isolated survivor of the family in Juan Fernandez—*Thyrsopteris elegans*. It is true that a considerable number of ferns of Jurassic and Wealden age have been described by the generic name Thyrsopteris without any adequate reason; but, neglecting all doubtful forms, there remain several types represented in the Jurassic flora of Siberia, England, and other parts of the world, which enable us to refer them with confidence to the Cyatheaceæ and to compare them more particularly with the sole existing species of Thyrsopteris. The Gleicheniaceæ, at present characteristic of tropical and southern countries, were undoubtedly abundant in the northern hemisphere in early Cretaceous days; abundant traces of this family are recorded from Greenland as well as from more southern European latitudes.

One of the most striking facts afforded by a study of the Mesozoic fern vegetation is the former extension and vigorous development of two families, the Dipteridinæ and Matonineæ, which are now confined to a few tropical regions and represented by six species. The tall graceful fronds of *Matonia pectinata*, forming miniature forests on the slopes of Mount Ophir and other districts in the Malay Peninsula in association with *Dipteris conjugata* and *Dipteris Lobbiana*, represent a phase of Mesozoic life which survives—

"Like a dim picture of the drowned past."

The fertile fragment of a frond of Matonidium exposed by a stroke of the hammer in a piece of iron-stained limestone picked up on the beach at Haiburn Wyke (a few miles north of Scarborough), is hardly distinguishable from a pinna of the Malayan *Matonia pectinata*. Rhætic and Jurassic ferns referred to the genus Laccopteris afford other examples of the abundance of the Matonineæ in the northern hemisphere during the earlier part of the Mesozoic era.

The modern genus Dipteris, with its four species occurring in India, the Malayan region, Formosa, Fiji, and New Caledonia, stands apart from the great majority of Polypodiaceous ferns, and is now placed in a separate family—the Dipteridinæ. Like Matonia it is essentially an ancient and moribund type with hosts of ancestors included in such Rhætic and Jurassic genera as Dictyophyllum, Camptopteris, and others which must have been among the most conspicuous and vigorous members of the Mesozoic vegetation. The appended table illustrates in a concise form the former extension of the Matonineæ and Dipteridinæ:—

geological history written in the rocks that constitute the Wealden series of Britain exposed in the Sussex cliffs and in the Weald district of south-east England. According to the geologist's reckoning, the Cretaceous period is of comparatively modern date; it occupies a position near the summit of a long succession of ages representing an amount of time beyond the power of imagination to conceive. On the other hand, to quote from Huxley's lecture on a piece of chalk, "not one of the present great physical features of the globe was in existence. . . .Our great mountain-ranges, Pyrenees, Alps, Himalayas, Andes, have all been upheaved since the chalk was deposited, and the Cretaceous sea flowed over the sites of Sinai and Ararat." This Cretaceous epoch, so recent geologically if measured by the standard of the antiquity of the everlasting hills, has a remoteness beyond our power to appreciate.

One interesting fact as regards the composition of the Jurassic Flora is the absence of any plants that can reasonably be identified as Angiosperms. In the Wealden flora of England no vestige of an Angiosperm has been found; this statement holds good also as regards Wealden floras in most other regions of the world. On the other hand, as soon as we ascend to strata of slightly more recent age we are confronted with a new element in the vegetation, which with amazing rapidity assumes the leading *rôle*. It is impossible to say with confidence at what precise period of geological history the Angiosperms appeared. When the rocks that now form the undulating country of the Weald were being accumulated as river-borne sediments on the floor of an estuary, this crowning act in the drama of plant evolution was probably being enacted.

"Nothing," wrote Darwin to Sir Joseph Hooker in 1881, "is more extraordinary in the history of the vegetable kingdom, as it seems to me, than the apparently very sudden or abrupt development of the higher plants. I have sometimes speculated whether there did not exist somewhere during long ages an extremely isolated continent, perhaps near the South Pole." We date the appearance of a new product of evolution from the age of the strata in which it first occurs; but this may well be a misleading criterion: all that we can say is that at a particular period certain new types of organisms are brought within our ken.

To quote Darwin again: "We continually forget how large the world is, compared with the area over which our geological formations have been carefully examined; we forget that groups of species may somewhere have long existed, and have slowly multiplied, before they invaded the ancient archipelagoes of Europe and the United States. We do not make due allowance for the intervals of time

Geographical Distribution of the Matonineae and Dipteridinae.

Matonineæ and Dipteridinæ	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
MATONINEÆ																						
Matonidium ... ... *Laccopteris* ... ... [Rhætic → Cretaceous]		×		×				×			×								×			
Matonia 2 species																×						
DIPTERIDINÆ																						
Dictyophyllum ... ... *Camptopteris*, &c. ... ... [Rhætic → Wealden]							×	×			×	×				×	×		×			
Dipteris 4 species																×						

Could we but question these survivors from the past, we should hear a tragic story of hopeless struggle against stronger competitors, and learn the history of their gradual migration from an ancient northern home to regions at the other end of the world.

e. *Flowering Plants.*

Our retrospect of the march of plant-life has so far extended to the dawn of the Cretaceous period, a chapter in

which have elapsed between our consecutive formations, longer, perhaps, in many cases than the time required for the accumulation of each formation."

On another occasion Darwin wrote to his friend Hooker: "The rapid development, as far as we can judge, of all the higher plants within recent geological times is an abominable mystery." Such evidence as we possess, meagre as it admittedly is, shows that "this overshadowing type of plant-life" no sooner appeared than it asserted itself

with extraordinary vigour and created a revolution in the plant-world. Let us glance for a moment at the facts to be gleaned from an examination of the records of this critical period in the history of vegetation.

I have already pointed out that we have as yet recognised no Angiosperms in the Wealden floras of England, Spitzbergen, Germany, France, Austria, Belgium, Russia, and Japan; but from plant-bearing rocks of Portugal, regarded as homotaxial with those which British geologists speak of as Wealden, the late Marquis of Saporta named a fragment of a leaf *Alismacites primaevus*, a determination that, while possibly correct, cannot be accepted as conclusive testimony. In Virginia and Maryland there occurs a thick series of strata known as the Potomac formation from which a rich harvest of plant-remains has been obtained. Prof. Lester Ward has recently shown that under this title are included several floras, some of which are undoubtedly homotaxial with the Wealden of Europe, while others represent the vegetation of a later phase of the Cretaceous era. From the older Potomac beds a few leaves have been assigned to Dicotyledons and referred to such genera as Ficophyllum, Myrica, Proteæphyllum, and others. Some of these may well be small fronds of ferns with venation characters like those of the Elk's Horn fern (Platycerium), while others, though presenting a close resemblance to Dicotyledonous leaves, afford insufficient data for accurate generic identification. In dealing with fossil leaves of the dicotyledonous type, we must not forget that the recent genus Gnetum—a gymnosperm of the section Gnetales—possesses leaves that may be said to be indistinguishable in form and venation from those of certain Dicotyledons. Before the close of the Potomac period these few fragmentary relics of possible Dicotyledons are replaced by a comparative abundance of specimens which must be accepted as undoubted Angiosperms. Previous to the discovery of the supposed Angiosperms in Wealden strata of Portugal and North America, the earliest record of an Angiosperm was represented by Heer's *Populus primaeva* from Northern Greenland. This name was applied to a fragmentary specimen which may be a true dicotyledonous leaf. In 1897 Dr. White, of the Geological Survey of the United States, stated that additional examples of dicotyledonous leaves had been obtained during the visit of the Peary Arctic expedition to the well-known locality in Greenland where Heer's *Populus primaeva* was discovered in the so-called Kome series. From strata known as the Atane beds, which rest on the Kome series, unmistakable Angiosperms have been collected in abundance.

Another indication of the sudden increase in the number of dicotyledons is furnished by the Dakota flora of the United States—in age somewhat more recent than the older Potomac beds. In these plant-beds it is stated that Angiosperms constitute two-thirds of the vegetation.

We may sum up the whole matter in a few words. There is some evidence of the existence of Angiosperms before the close of the Wealden period. It may be added that the Stonesfield Slate of England (a formation of approximately the same age as the Inferior Oolite plant-beds of Yorkshire) has afforded a single specimen of a leaf which in form and venation has as much claim to be referred to the dicotyledons as many of the leaves from Wealden rocks. These earliest records are, however, unsatisfactory, and the names assigned to them are often misleading. As soon as we ascend a stage higher in the geological series, not only do the Angiosperms at once become abundant, but the whole facies of the vegetation undergoes a striking change. The Gymnosperms, especially the Cycads, are ousted from a supremacy maintained through countless ages, and the vegetation becomes essentially modern. Many of the earlier angiospermous plants may be referred to existing genera and present no features of special interest from a phylogenetic standpoint.

One of our most pressing needs is a thoroughly critical revision of the late Cretaceous and earlier Tertiary floras, with the object both of determining the systematic position of the older Angiosperms and of mapping out with greater accuracy the geographical distribution of the floras of the world in post-Wealden periods. This is a task which is sometimes said to be impossible or hardly worth the attempt; the available evidence is indeed meagre, and much of it has been treated with more respect than it deserves, but it is at least a praiseworthy aim, not to say a duty, to take stock of our material and to compile lists of plants that may bear the scrutiny of experienced systematists. We are profoundly ignorant of the means by which Nature produced this new creation; we can only emphasise the fact that in the early days of the Cretaceous era a new type was evolved which no sooner appeared than it swept all before it and by its overmastering superiority converted the past into the present.

Conclusion.

In conclusion, I would urge the importance of taking stock of our accumulated facts, and of so recording our observations that they may be safely laid under contribution as aids to broad generalisations. Detailed descriptions and the enumeration of small collections are a necessity, but there is danger of the student neglecting the application of his results to problems of far-reaching import. We may borrow a saying of a great artist in regard to attention to detail—"I see it, but I prefer to construct the synthesis."

There is no more fascinating task than to follow the onward march of the plant-world from one stage to another and to watch the fortunes of the advancing army. We see from time to time war-worn veterans dropping from the ranks and note the constant addition of recruits, some of whom march but a short distance and fall by the way; while others, better equipped, rise to a position of importance.

At long intervals the formation is altered and the constitution of the advancing and increasing host is suddenly changed; familiar leaders are superseded by new-comers who mark their advent by drastic reorganisation. To change the metaphor, we may compare the stages of plant-evolution to the records of changing architectural styles represented in Gothic buildings. The simple Norman arch and massive pier are replaced, with apparent suddenness, by the pointed arch and detached shafts of the thirteenth century; the latter style, which marked an architectural phase characterised by local variations subordinated to a uniformity in essential features, was replaced by one in which simplicity was superseded by elaboration, and new elements were added leading to greater complexity and a modification of plan. Similarly the Palæozoic facies of vegetation passes with almost startling suddenness into that which monopolised the world in the Mesozoic era, and was in turn superseded by the more highly elaborated and less homogeneous vegetation of the Cretaceous and Tertiary periods. In taking a superficial view of architectural styles we are apt to lose sight of the signs of gradual transition by which one period passes into the next; so, too, in our retrospect of the changing scenes which mark the progress of plant-evolution, we easily overlook the introduction of new types and the gradual substitution of new for old. The invention of a new principle in the construction of buildings is soon followed by its wide adoption; new conceptions become stereotyped, and in a comparatively few years the whole style is altered. As a new and successful type of plant-architecture is produced it rapidly comes into prominence and acts as the most potent factor in changing the facies of a flora. Making due allowances for the imperfection of the Geological record, we cannot escape from the conclusion, which is by no means opposed to our ideas of the operation of the laws governing evolutionary forces, that the state of equilibrium in the vegetable kingdom was rudely shaken during two revolutionary periods. The earlier transitional period occurred when Conifers and Cycads became firmly established, while for the second revolution the introduction of the Angiospermous type was mainly responsible. As in the half-effaced documents accessible to the student of architecture "the pedigrees of English Gothic can still be recovered," so also we are able to trace in the registers imprinted on the rocks the genealogies of existing botanical types.

In the course of this address I have given but scant attention to the lessons we have learnt and are still to learn as to the family-history of plants. As Prof. Coulter says: "The most difficult as well as the most fascinating problem in connection with any group is its phylogeny. The data upon which we base opinions concerning phylogeny are never sufficient, but such opinions usually stimulate research and are necessary to progress."

We who attempt to read the records of the rocks may be tempted to magnify the importance of the work, but I do not hesitate to add that botanists as a whole have but half realised the fact that the study of living plants alone supplies but a portion of the evidence bearing on problems of plant-evolution. To ignore the facts that may be gleaned from the investigation of extinct types is like attempting to draw up a genealogy by merely questioning an individual without consulting the documentary evidence of registers and other chronicles.

Each successive stage through which the organic world has passed contains some relics of a preceding age; in comparing the chalk with the calcareous ooze now accumulating on the bed of the Atlantic, Carpenter expressed the partial agreement between the two deposits by saying that we are still living in the Cretaceous period. Dr. Moore's recent researches, demonstrating a striking resemblance between many of the molluscs of Lake Tanganyika and fossils preserved in the sediments of Jurassic seas, led him to describe some constituents of the fauna of this inland lake as so many "lingering shadows of the past," while Tanganyika itself is a dwindled remnant of a Mesozoic sea. Similarly our modern vegetation differs enormously from that of the Mesozoic era, yet in the sago-palms of the Tropics and in species of Malayan ferns we recognise proofs of the continuity of plant-types through successive ages. One stage is superseded by another, but some characteristic elements of each period persist into the next, carrying on the traditions of the past and demonstrating the futility of our system of classification, a system in which we express the limitations of our knowledge, as we suit our convenience, by dividing into periods the history of geological and organic evolution.

"It is only our ignorance that fixes a limit, as the mist gathered round the mountain's brow makes us fancy we are treading the edge of the universe."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

In connection with the Technical Education Board of the London County Council, a course of ten free lectures to teachers on "Animal Life in a Freshwater Aquarium" will be given by Dr. A. C. Haddon, F.R.S., at the Horniman Museum on Saturday mornings, at 11.30, from October 10 to December 12. Tickets of admission may be obtained from the Clerk of the London County Council, County Hall, Spring Gardens, S.W.

A course of eight lectures on "The Relation of the Composition of the Plant to the Soil in which it Grows" will be given at the Chelsea Physic Garden by Mr. A. D. Hall (director of the Rothamsted Experimental Station) on Tuesdays from October 13 to December 8, in connection with the University of London. The lectures are addressed to advanced students. Two courses of lectures on advanced physiology will be given at the university during the present session. Commencing on October 16, Dr. F. W. Mott, F.R.S., will lecture on "The Structure and Function of the Cerebral Cortex," and on October 20 Dr. Buckmaster will lecture on "The Blood." On October 13 Dr. A. D. Waller will lecture on "The Anæsthetic Action of Chloroform and Ether." Admission to the lectures is by ticket, to be obtained from the Academic Registrar.

The Act of Parliament under which the University College of Liverpool, hitherto associated with Owens College, Manchester, and Yorkshire College, Leeds, in Victoria University, begins its independent existence as the University of Liverpool, came into operation on October 1. This charter, which was obtained last July, provides that all the courses shall be open to women. Lord Derby is the first Chancellor and Principal Dale the Vice-Chancellor, and the university possesses a strong staff. Chairs have recently been endowed in tropical medicine, bio-chemistry, and electrotechnics, besides additions to other teaching resources. It is anticipated that the existence of the new university will greatly stimulate the work in the secondary a well as other schools.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 28.—M. Albert Gaudry in the chair.—The myelocytes of the olfactory bulb, by M. Johannes **Chatin**.—Remarks by M. Alfred **Picard** on the "Rapport général administratif et technique sur l'Exposition universelle internationale de 1900."—On a combination of aluminium sulphate with sulphuric acid, by M. E. **Baud**. By the action of sulphuric acid upon bauxite, aluminium hydrate, or aluminium sulphate, a compound possessing the composition $Al_2O_3.4SO_3.4H_2O$ is formed, which dissolves very slowly in cold water. It is analogous to the ferrisulphuric acid of M. Recoura.—On the nitrosite of pulegone, by M. P. **Genvresse**. Pulegone, dissolved in petroleum ether, and saturated with either nitrogen peroxide or nitrous fumes from starch and nitric acid, gives a nitrosite, $C_{10}H_{16}.N_2O_3$, the properties of which are described.—On the production of sulphuretted hydrogen by extracts of organs and albumenoid materials in general, by M. Emm. **Pozzi-Escot**. Yeast extract, treated with sulphur, gives rise to a considerable quantity of sulphuretted hydrogen; if the extract is boiled for a short time before adding sulphur, no sulphuretted hydrogen is evolved. From this it is concluded that the reaction is of a diastatic nature. —On the phagocytic resorption of unutilised genital products in *Echinocardium cordatum*, by MM. Maurice **Caullery** and Michel **Siedlecki**.—On the formation of the egg and the multiplication of an antipode in Juncus and Luzula, by M. Marcellin **Laurent**.—The morphological variation in the leaves of the vine following grafting, by M. A. **Jurie**. The experiments described show the great variability of certain morphological characters in the leaf of the vine under the influence of grafting.—On the relations between the structure of the French and Swiss Alps, by M. **Kilian**.

CONTENTS.

THURSDAY, OCTOBER 15, 1903.

EGYPTIAN GEOLOGY.

Topography and Geology of the Eastern Desert of Egypt (Central Portion). By T. Barron, A.R.C.S., F.G.S., and W. F. Hume, D.Sc., A.R.S.M., F.G.S. Geological Survey Report. Pp. viii + 331. (Cairo: National Printing Department, 1902.)

THE work before us is the largest instalment yet published of the results of the explorations which have been carried on with such success by the Egyptian Geological Survey, under the able and energetic direction of Captain Lyons. The district now described was actually surveyed in the years 1897 and 1898, but there appear to have been many delays in arranging for the publication—the time of the authors being taken up by fresh work undertaken in widely distant regions. At the geological congress held in Paris in 1900, however, the two authors of the memoir were permitted to lay some of the chief results obtained from the study of this region before the geologists who had assembled there, and abstracts of their papers have appeared in the *Geological Magazine* for 1901; but the publication of this large and well-illustrated memoir has long been eagerly anticipated, and its appearance will be everywhere welcomed as a most valuable addition to the scientific literature of the district.

The authors must be congratulated upon the excellent use they have made of the vast mass of literature dealing with the geology of the area. In an appendix they have given an admirable abstract of the results obtained by De Rosière, Wilkinson, Schweinfurth, Klunzinger, Walther, and many other travellers, who have by their writings added to our knowledge of this very interesting region. The work of the geological surveyors—a very important one—has been that of correlating and correcting these various sources of information and of supplying, by actual observations in the field, the links necessary to combine the whole into a connected monograph dealing both with the topography and geology of the district.

Like the work carried on in the western territories of North America by the United States Geological Survey, the work in the Egyptian deserts has to be a combination of a geological and a topographical survey. Each working party had to consist of a geologist and a topographer, with a small caravan consisting of eleven Arabs and fifteen camels. The topographical work was done by using a measuring wheel for determining a base line, and working from this with plane-table and theodolite, frequent observations for latitude being made to correct the results; the heights were determined by the aneroid in most instances, but in important cases hypsometer and theodolite determinations were made also. The chief difficulties experienced in the topographical work—apart from those arising from traversing waterless districts—were caused by the mirage and by the frequent presence of great masses of magnetic rock.

While the topographers were engaged in making the map as complete as possible, the geologists were busy examining and recording the interesting features exhibited by the various rock-masses encountered in the different traverses. The district described includes the famous porphyry quarries of Djebel Dokhan, and the ancient upraised coral reefs and their modern representatives on the shores of the Red Sea—some of these reefs being of especial interest, owing to the partial dolomitisation which they have undergone.

The first 115 pages of the volume (which extends to 331 pages) are occupied by an account of the topography of the Red-Sea Hills, and in this part of the work there is much matter of archæological interest in the account of the numerous remains of Roman buildings, and of ancient quarrying and mining works. A very excellent account is also given of the meteorology and of the botany and zoology of the district.

The description of the geology which occupies the second and larger half of the volume deals with the Pleistocene gravels, old beaches, and raised coral reefs, the Pliocene gravels, conglomerates and limestones, the Miocene and Eocene limestones, marls, &c., the Cretaceous limestones, and the "Nubian Sandstone," which in this particular district appears to be in no part older than the Cretaceous. The sedimentary rocks of the district are about 2000 feet in thickness, and cover unconformably the metamorphic and associated igneous rocks. The latter consist of quartz-diorites or grey granites which are younger than and invade the metamorphic rocks, and are themselves intruded into by masses of red granite, with, probably associated, dykes of quartz-felsite and dolerite. These rocks with veins of diabase which intersect them have all been planed down by denudation before the deposition of the sedimentaries. The only later igneous rocks are the andesites which have been intruded into the Eocene limestones, and have produced contact metamorphism in them, and certain igneous gravels and conglomerates which unconformably overlie the sandy limestones of Pliocene age.

The volume is admirably illustrated. Besides the general topographical map of the district and the same geologically coloured, there are five geological maps of areas of special interest. There are also four plates containing coloured panoramas, which give an excellent idea of the relations of the various igneous and other rock masses in this region; and the geological structure of the district is further illustrated by eleven plates of longitudinal sections. The general aspects of this, it must be confessed, rather uninviting region are shown by nine beautiful photogravures by Dr. E. Albert and Co., of Munich, from photographs taken by the authors, while three plates and six photographs are devoted to objects of archæological and general interest.

The important palæontological researches of Beadnell and Andrews have attracted the attention of all geologists to the important work which is being accomplished by the Geological Survey of the Egyptian Government, and the present work will serve to show that every branch of geological science is receiving

due attention from the officers of that survey. It is well known that important explorations have been carried on in other portions of the vast territories now under the rule of the Khedive, and it may be hoped, in the interests of science, that these results may be published with less delay than those we have now been noticing. J. W. J.

EXPERIMENTS ON HUMAN MONSTERS.

Essai sur la Psycho-physiologie des Monstres Humains. By N. Vaschide and Cl. Vurpas. Pp. 294. (Paris: F. R. de Rudeval, n.d.) Price 5 francs.

THE substance of two-thirds of this book has already appeared in various scientific and medical journals. The last ninety-four pages are devoted to the researches of other workers in the same field. The first of the two monsters examined by the authors was an anencephalous male child, which was continuously under observation during the thirty-nine hours of its extra-uterine life. An examination *post mortem* revealed the complete absence of cerebral hemispheres, cerebellum, pons, restiform body, inferior and accessory olives, and pyramidal tract. The monster's apparent lack of taste and smell is devoid of theoretical interest, as the authors omit to mention whether the trigeminal and olfactory nerves were developed. Certainly they failed to find traces of the third and fourth cranial nerves, coincident with the lack of which the infant presented exophthalmos, external squint, dilatation of the pupil, absence of the pupil-reflex, and ptosis. The cerebral hemispheres were replaced by a protruding cystic tumour; throughout the brain and cord the ependyma, neuroglia and ventricles were much hypertrophied, and atrophied degenerated nerve-cells were met with, especially in the cranial region, together with much vascular engorgement and diapedesis. In order to explain the yet healthy state of the retinæ and optic nerves, the authors conclude that the cerebral hemispheres at first developed normally, and were only later affected by "an inflammatory process of an infectious nature," which produced the anencephaly and other abnormalities. But the authors' interpretation of their histological investigations is far from convincing. It is hardly a matter for surprise to find hæmorrhages and wandering leucocytes in the profoundly disturbed nervous system of a cold, moribund, cyanotic creature that breathed only about eight times a minute, and then with a well-marked Cheyne-Stokes rhythm. Moreover, some secondary degeneration may have followed from the complete absence of the pyramidal tract. The authors allude to an insufficiency of myelinisation and to the abnormal proportions between white and grey matter. But these statements, and the rather indifferent plates and illustrations upon which they are founded, would have carried greater conviction, were it certain that the authors (of whom one is an experimental psychologist and the other a hospital resident physician) are perfectly familiar with the corresponding appearances in a healthy newly-born babe.

On pp. 47 and 48 we read:—

> "It seems that a class of psychic phenomena, which hitherto have been attributed exclusively to the cerebral hemispheres, such as the special sensibility to touch, pain, and warmth . . . existed in our anencephalous subject independently of the action of the brain."

In point of fact, the reflex movements experimentally obtained by tactual, painful, and thermal stimuli, likewise the abortive attempts of the subject to swallow, its cries and convulsive seizures, one and all are just what might have been expected from a "decerebrate" vertebrate; they are quite void of "psychic" significance in the ordinary meaning of the term, and throw no fresh light on the subject whatever. Surely the presence of these reflex actions, and the integrity of the nerve-trunks, might have led the authors to suspect that nerve-cell degeneration had been neither as extensive nor as intense as they had imagined. But, on the contrary, they incline (p. 76) "to the opinion of certain authors who see in the cell a centre having a function purely trophic and in no way motor," and further urge (p. 75) the impossible view that the infant's (very doubtful) manifestations of spontaneous activity "seem to show that the pyramidal tract has a *rôle* essentially inhibitory instead of dynamogenic." The authors might to their advantage have kept in mind the words of their own preface (p. 16):—

> "Nous avons laissé à dessein de côté dans nos travaux et recherches les hypothèses, . . . en nous imposant de ne pas sortir du cadre de l'expérience et des données précises."

The subject of the second far more satisfactory study was a "xiphopage," as the authors call it, in other words, an example of Siamese twins. It was composed of two perfectly formed Chinese boys, fifteen years old, of whom the right was called Liao Toun Chen and the left Liao Sienne Chen. They were united in the region of the xiphoid part of the sternum by a somewhat extensible bridge of tissue which contained cartilage, blood vessels, and very probably a remnant of hepatic substance. This bridge revealed a narrow median anæsthetic zone, surrounded on either side by a hypoæsthetic zone, cutaneous stimulation of which affected only that individual to whom the stimulated area was nearest, but never both individuals. It is, however, difficult to reconcile this interesting observation with another, viz. that if the points of Weber's compasses were separated by 15mm., and the compasses placed astride the median anæsthetic zone, so that one point rested on an area felt by one subject, and the other on an area felt by the other subject, then each child perceived that he was touched in two points. The characteristics of the two children were very different. Liao Toun Chen was mentally and physically more vigorous than his brother. He was more curious and roguish, while Liao Sienne Chen was more attentive and serious. The latter, as we should expect, gave shorter and more trustworthy reaction-times. His sensibility to stimuli was also keener. His body-temperature and his arterial pressure were higher than those of his stronger brother, who in turn breathed with greater rapidity, and had a more frequent pulse. Save in

violent emotion, the respirations of the two brothers were never isochronous, but in opposite phases. Owing to congenital association, these differences of character were found to be harmonised, as might be anticipated, in action. Quarrels were rare; Liao Sienne Chen meekly followed his better half. They had from their birth eaten and performed other functions simultaneously. In waking, however, one recovered consciousness before the other, and roused him. It was found possible for one of the brothers to sleep while the other kept awake. But does this in reality, as the authors affirm (p. 175), "speak singularly against a chemical theory of sleep which makes it appear under the influence of toxic products"?

C. S. MYERS.

OUR BOOK SHELF.

Electrolytic Preparations. By Dr. Karl Elbs, translated by R. S. Hutton, M.Sc. Pp. xi + 100. (London: Edward Arnold, 1903.) Price 4s. 6d. net.

ELECTROCHEMICAL methods are now becoming of such importance, and are being so largely employed both in the laboratory and in technical processes, that the translation of Dr. Elbs's little work on electrolytic preparations—"Exercises for use in the laboratory by chemists and electrochemists"—will be sure to be welcomed by English-speaking students.

The book is divided into two parts. Part i., which is general, deals with sources of current and connections, resistances, apparatus for electrolysis, &c. Dr. Elbs considers that accumulators can alone be looked upon as a source of current for laboratory purposes, and he gives some useful hints as to coupling up and how to use the cells.

Several pages are devoted to apparatus for electrolysis. As kathode material almost any metal may be employed, unless the electrolyte is very strongly acid. But for anodes, nearly all metals, with the exception of platinum, are attacked. Lead may often be used owing to its becoming coated with a superficial layer of peroxide which prevents further action taking place.

Part ii. is devoted to the experimental portion of the work. The examples from inorganic chemistry which come first are divided into two parts. The first deals with experiments with unattackable anodes, the second portion with soluble anodes. Under the first heading are given the methods of preparation of such substances as chlorates, bromates and iodates, and persulphates, under the second heading the preparation of white lead, cuprous and cupric oxide.

On p. 47 the student is introduced to the electrolysis of organic acids. This part is well arranged, and the theoretical principles are carefully and clearly gone into. A detailed explanation is given of the various reactions which may occur in the electrolysis of organic acids. Here there seems to be a field for further research, because although many of the explanations given probably approximately explain what actually does occur, others seem hardly conclusive, so that at any rate further light upon the subject would be welcome.

No less than eighteen examples of electrolytic reduction are given, while there are only two on electrolytic oxidation. This is mainly due to the fact that reduction work, generally speaking, is much easier to carry out than work on oxidation. This applies both to pure chemistry and to electrochemistry. Further, electrochemical methods of oxidation have not been tried by chemists to anything like the same extent as have reduction methods.

The book is very well printed and got up, and Mr. Hutton has done his part—the translation of the work—very satisfactorily.

F. M. P.

A Concise Handbook of Garden Flowers. By H. M. Batson. Pp. vii + 256. (London: Methuen and Co., 1903.) Price 3s. 6d.

THIS is an alphabetical list of a large number of ordinary garden plants, together with brief indications of height, colour of flowers, native country, natural order, season of flowering, mode of propagation, and purpose for which they may be used in the garden. Within its rather restricted limitations the book seems carefully compiled, and the proofs have evidently been read with attention, for abundant as are the opportunities for falling into error, misprints are hardly to be found. The word "family" is, however, used in many cases where "genus" should be employed; thus the Galegas are styled a hardy family. Of course, Galega is a genus of the family Leguminosæ. An even more misleading statement is that in which *Narcissus Barrii* is spoken of as "a family of star-narcissus," whatever that may be.

The cultural details, though very concise, are apparently trustworthy, but there is ample room for difference of opinion about these matters. Thus the author says of *Gentiana acaulis* that "it is easy of culture." It may be so in places, but after a long experience with it under varying conditions, but in one particular garden, we have never been successful in getting it to flower, whilst in another we have experienced no difficulty. The author has succeeded in finding English names for most, if not all, of the plants he mentions. If such names are to be given, they should be employed with as much precision as the technical appellations. To call *Narcissus poeticus* the "poet's daffodil," or *Narcissus Tazetta* "the polyanthus flowered daffodil," is surely to introduce confusion where none need be experienced. A full index is added, which adds greatly to the convenience of the reader. We should like to suggest to the author that, in a future edition, he should enumerate the names of the genera in alphabetical order under the heading of the natural order to which they belong. Search for the name of a plant would by such means be much facilitated, as most lovers of plants are familiar at least with the principal natural orders.

Lavori marittimi ed Impianti portuali. By Flavio Bastiani. Pp. xxiv+424. (Milan: Ulrico Hoepli, 1903.) Price 6.50 lire.

THIS is one of the "Manueli Hoepli," a series of pocket books in which the Italian "man in the street" can, at a small cost, obtain information on such diverse subjects as elliptic functions, Volapük, botany, oils and olives, Greek mythology, and English weights and measures. The present volume deals with the construction and working of docks, harbours, wharves, canals, lighthouses, in short all fixed structures connected with navigation. It is illustrated by 209 woodcuts, and the last part contains a summary of Italian laws relating to harbours, harbour dues, and such matters.

Il Moto degli Ioni nelle Scariche elettriche. By Augusto Righi. Pp. 66; with 3 plates and several woodcuts. (Bologna: Nicola Zanichelli, 1903.)

THIS book contains, with some amplifications, an almost verbatim report of a lecture delivered by Prof. Righi to a branch of the Italian Electrotechnical Society at Bologna. It deals with the theory of electrons, considered with special reference to kathodic rays, ionisation of gases, Lorentz's theory, and the production of electric shadows.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Radium and the Sun's Heat.

IN your last week's issue Mr. Hardy directs attention to the fact that no Becquerel rays can be detected from the sun, and regards this as an objection to the view that the solar heat may be accounted for by the presence of radium.

Let us attempt to calculate the effect to be expected if the sun's heat were due to this cause.

In doing this, we may assume that the sun contains 3·6 grams of radium per cubic metre. This was the amount which Mr. W. E. Wilson gave in NATURE of July 9 as required to emit the observed amount of heat. Experiment shows that when the Becquerel radiation has to pass through lead screens of thickness 1 cm. or more, the radiation transmitted is practically all of the γ variety. This is cut down to half its value by 8 cm. of aluminium, and in the case of other substances by strata of equal mass per unit area. Now the earth's atmosphere constitutes a stratum far more absorbent than 1 cm. of lead. We need, therefore, only consider the γ rays, for if these cannot be detected, it is certain that the α and β rays cannot.

For the sake of simplicity of calculation, we shall treat the sun as a cube, with its side equal to the diameter of the real sun; and so placed that the normal to one face, which passes through the centre, shall also pass through the earth. This will be for all practical purposes near enough to the truth.

Let a be the side of the cube, q the quantity of radium per c.c., and λ the coefficient of absorption of the radiation. Then, from an elementary slice, thickness dx, and distance x from the face, the intensity of radiation at a distant point will be

$$a^2qe^{-\lambda x}dx$$

if the radiation due to 1 gram of pure radium at the same (great) distance be taken as unity.

The radiation due to the entire mass will be

$$a^2q\int_0^a e^{-\lambda x}\,dx=a^2q\left[\frac{-e^{-\lambda x}}{\lambda}\right]_0^a=\frac{a^2q}{\lambda}\left(1-e^{-\lambda a}\right)$$

Now $a=1\cdot4\times10^{11}$ cm.; q, from Mr. Wilson's estimate $=3\cdot6\times10^{-6}$.

Assuming that the coefficient of absorption is proportional to the density, and taking the sun's density as 1/7, and the value of λ for aluminium as 0·086, the value of λ for the sun comes out 0·0046. Substituting these values, we find that the effect of the sun is equivalent to that of $1\cdot53\times10^{19}$ grs. of radium at the same distance, assuming this radium to be spread out into a thin layer, so that all the radiation can escape without undergoing absorption in the mass.

Now I have found that the γ radiation from 10 milligrams of radium bromide can barely be detected by the electrical method, where 10 cm. of lead intervene between it and the testing vessel. To decide whether the solar rays would be detectable, we must compare their expected effect after enfeeblement by distance, and by the absorption of the atmosphere, with this.

The distance of the sun is 1.5×10^{12} times greater than the distance of the radium from the testing apparatus, so that, apart from the atmospheric absorption, the effect of the sun would be equivalent to that of $\frac{1.5\times10^{19}}{(1\cdot5)^2\times10^{24}}$, or $6\cdot7\times10^{-6}$ grams of radium, 10 cm. from the apparatus. This is less than one-thousandth part of the radium used in the experiment cited, and the solar radiation, instead of passing through only 10 cm. of lead, would have to pass through the atmosphere, equal in mass to 32 feet of water, or about 89 cm. of lead. This would, of course, reduce it many million times further. So that, even if all the sun's heat were due to radium, there does not appear to be the smallest possibility that the Becquerel radiation from it could ever be detected at the earth's surface.

R. J. STRUTT.

REFERRING to Mr. Hardy's experiment described in his letter in NATURE, October 8, it is easy to show that whatever the intensity of radio-activity might be at the surface of the sun, by mere surface ratios and assuming no absorption its activity per unit area at the distance of the earth must fall to about one forty-thousandth part. Now, if the sun were composed of solid radium bromide, the radiation reaching Mr. Hardy's indicator from the sun will be only about one-thousandth part of that derived from a sphere of radium bromide three millimetres in diameter and twenty millimetres distant from the indicator: the probable conditions of Mr. Hardy's experiment.

In the experiment one centimetre thickness of lead is interposed. The earth's atmosphere is equivalent in mass to 76 cm. of mercury. This supposes no absorption from, possibly, some thousands of miles of solar atmosphere. Moreover, we assume in the comparison a sun of solid radium bromide. It would appear, however, that a very small percentage of this body in the materials of the sun would suffice to account for many millions of years of solar heat.

The absence of β and γ radiations at the earth's surface is, therefore, not a weighty argument against the presence of radium in the sun.

The arguments in favour of supposing that this element exists in the sun are:—(1) The presence of radium on the earth; (2) the high atomic weight of radium; (3) the presence of helium in the sun; (4) Arrhenius's theory of the Aurora Borealis; (5) the fact that the estimate of the duration of solar heat from the dynamical source appears to run counter to geological data.

J. JOLY.

Trinity College, Dublin, October 10.

Cambridge in the Old World and in the New.

ONE of the most striking features of the universities of the United States is the wealth of their endowment. During the writer's visit to Cambridge, Massachusetts, for example, Harvard University was successfully collecting large sums towards a new building for philosophy in memory of Emerson, and within the last few months has been promised two million dollars by two millionaires towards her new medical school.

Reasons for such well-known munificence of Americans towards their universities are not hard to find. Pauperism is an almost negligible quantity in America, so that the money, which drains away on this side in charity, finds an outlet there in the advancement of education and research. Primogeniture, again, is contrary to American ideals. While the newly-made English millionaire thinks it his duty to sink a considerable part of his fortune in buying and maintaining a family estate for his son and heir, the American more often divides his property equally between his children, and feels at greater liberty to dispose of much of it in his lifetime as he pleases, for he is willing that the uphill life he has lived himself shall be lived again by his descendants. The absence of inherited titles in America tends, of course, towards the same end. Many of the younger universities, too, are in districts where huge fortunes have been rapidly made and civic pride runs high, producing numerous benefactions in the cause of local institutions. But although all these are reasons, none of them is sufficient to explain the situation satisfactorily. To find the true cause, we must enter into the differences in life and education between the older English and American universities.

The average English youth, passing from public school to Oxford or Cambridge, intends to make his living by some profession, perhaps as minister, teacher, barrister, or physician; relatively seldom has he sufficient to live upon without further exertion. He spends his three or four years in one of the seventeen or more colleges from which he has to choose, and his college becomes the centre of his social life. Probably there he makes his greatest friendships; certainly the number of men he knows outside his own college is comparatively small. In eights, elevens, or fifteens, the various colleges are pitted against one another. Nor, indeed, is inter-collegiate competition confined to athletics. Each college is continually struggling against the rest to secure the most promising boys from the public schools, and to acquire the greatest number of university distinctions. Each has to maintain a more or less separate

staff, partly to supplement university lectures, but partly also to give more individual instruction to the duller or idler students. One of the results of this system can be easily seen—the average graduate quits his university with the greatest affection for his college, but with little or nothing of that broader *esprit de corps* towards his university as a whole.

In America, on the other hand, each university has only one college preparing him for the B.A. degree. Consequently, a single American college, *e.g.* Harvard College, Cambridge, contains several thousand students.[1] The centre of social life can no longer be in the college; it is transferred to the class, the class consisting of all students who are in the same year. Each class elects its own president and other officers, has its various rowing, football, and baseball teams, and holds meetings for the discussion of matters of common interest. A class in Cambridge, Massachusetts, knits the students together in somewhat the same way as does a college in Cambridge, England, although, of course, far less closely.

In the second place, there is a comparatively large number of students in American universities, who intend to lead, or finally do lead, a business life after they leave college. It is true that just now the question is being raised whether a college training is the right one for an American business man, but the only probable outcome of this discussion will be an improved adjustment of the college curriculum in the interests of those who intend to embark on a business career. Already at Harvard there is a proposal on the part of the president to make it possible for such students to complete their training in a shorter time than the usual four years.

In the end these two American features, the formation of class ties and the presence of students who are intended for a business career, combine to place a number of wealthy *alumni* at the beck and call of the universities. It is a common occurrence for the class of a certain year to defray, wholly or in part, the cost of a building of which their *alma mater* stands in need; at Cornell alone twenty-two class-gifts of this or similar kind are on record. Moreover, the *alumni* of the various universities form themselves into societies, both local and general. Every important city in America contains various associations of *alumni*, each association representing one of the more important universities. The *alumni* of various classes, dispersed throughout the States, are periodically invited to revisit their university. In some universities they directly elect a certain number of their body to serve on the board of trustees or corporation of the university. Such is the hold exercised by many American universities on their former students.

But it is not only from wealthy *alumni*, but also from citizens who have never been to college, that the universities of the United States derive their greatest benefactions. Now this would be impossible unless the American people were in full sympathy with American university work. Indeed, the university holds as warm a place in the heart of the American as the hospital holds in that of the Englishman. He feels that it is a living organisation, not an inert out-of-date machine, which is doing necessary work in the advancement of the civilisation of his country. Further, we come to understand the reason of this feeling when we contrast the undergraduate courses at the two Cambridges. At Harvard, the examination for admission consists of papers in English, history, algebra, geometry, and natural science, Latin *or* Greek, and French *or* German. After passing this, the student has to choose four courses of lectures per year in *more than one* of the following subjects:—English, German, French, Italian, Spanish, history, government, economics, philosophy, fine arts, music, mathematics, engineering, or some natural science. Apart from certain reasonable restrictions, which prevent him from acquiring a too superficial knowledge in too many subjects, the student is at liberty to select just those courses which will best suit him in after life; and, of course, he can readily obtain advice in any difficulties that may beset him when making his choice. In his second and later years he may specialise more deeply in these and other subjects. He is examined twice a year, and shows thereby whether he is capable of proceeding to more advanced courses advantageously. He obtains his degree on the result of these bi-annual examinations. For an honours degree a thesis or special examination is required.

[1] The words college and university have thus acquired a significance in America which is unfamiliar to us. No college is regarded as a university unless, besides teaching, it encourages post-graduate research.

The undergraduate of our English Cambridge, on the other hand, having mastered at school the modicum of compulsory Greek required for the previous examination, has the choice of two distinct paths. He can straightway read for an honours degree in any *one* of the triposes which suits his requirements, the classical, mathematical, theological, natural sciences, mental and moral sciences, mechanical sciences, mediæval and modern languages, oriental languages, historical or other tripos—in which case he takes his degree almost always upon the results of a single examination in a single tripos at the end of his three years[1]; or he may be content to take an ordinary degree, for which he must devote at least the whole of his first year to Greek, Latin, English, algebra, statics, hydrostatics and heat, and spend his later years preparing for examination in any *one* subject (*inter alia*) of the following:—theology, economics, law, history, logic, mathematics, classics, music, chemistry, physics, botany, physiology, zoology, or agriculture. This examination, qualifying him for the ordinary B.A. degree, is completed at the end of his third year.

Few graduates who have been educated on the basis of a Cambridge tripos would welcome changes in so admirably conceived a system of education. At one time it was believed that the student who devoted his three or four years in this manner to a single subject must suffer in general culture, whereas it is nearer the truth to believe that there is scarcely any branch of learning which cannot impart a very high degree of culture, provided only that it be taught from a sufficiently wide and liberal point of view. On the other hand, there are probably few who would not desire considerable changes in the regulations for the ordinary degree. The examination is hardly more than an advanced Little-go, ending in a feeble effort at specialisation. Instead of having to spend a year or more at Greek, hydrostatics, heat, &c., why should it not be possible for the undergraduate who is bent on an army career to qualify in modern or oriental languages, geography, surveying, and ethnology, or for him who intends to enter into finance to study mercantile law, economics, and modern languages, or for the future country squire to read straightway in history, literature, law, and agriculture? Is a university to confine herself solely to the encouragement of research and to the preparation of ministers, teachers, physicians, engineers, and musicians? Or is it impossible to prepare men for other walks of life without the sacrifice of culture in the interest of practical needs? Surely America gives us a useful lesson as to the unwisdom of driving away such embryo financiers and others elsewhere owing to the lack of attractive and useful courses of study which they could pursue after leaving school. The expenses of administration in our universities increase so enormously from year to year that, unless they are to receive State aid or to decay from sheer stagnation, they must be continually appealing to the public for support. And public interest can only be maintained when the universities are prepared to equip men appropriately for many more different walks in life than they are at present. Such changes, which involve merely the framing of new regulations, cannot fail to be followed by an increase in benefactions, whereby training in languages, archæology, history, and economics may be improved, and the teaching and laboratories be alike brought to the requisite condition of efficiency for establishing a successful school of post-graduate research.

C. S. MYERS.

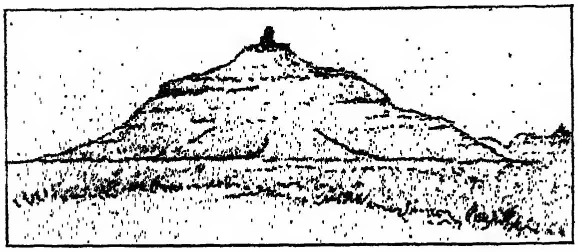
Gonville and Caius College, Cambridge.

[1] No mention is here made of the still more specialised second part of the triposes which corresponds in many respects to the training given in the post-graduate schools of the better American universities.

An Ancient Lava Plug like that of Mont Pelée.

THE photograph of what is described as "a gigantic plug of solidified lava" in the centre of the new cone of Mont Pelée, which appears in NATURE of October 1 (p. 530),

reminds me of similar columns of ancient lava not uncommon among the trap rocks of the Deccan, and I enclose a copy of a sketch I made of one of these in 1839, the re-



markable similarity of which to the column on Mont Pelée seems to be worthy of notice. A second similar column is seen in the distance on the right. RICHARD STRACHEY.

69 Lancaster Gate, W.

"Lessons on Country Life."

IN your issue of September 24 you published a review of "Lessons on Country Life," by Messrs. Buchanan and Gregory, but may I ask, with all deference, if your reviewer has not omitted to read an important part of this useful little book? He refers to Mr. Buchanan's earlier works, "Country Readers," Nos. 1 and 2, as "most excellent books for children," but had he read the *preface* to the "Lessons" he would have found that these were intended, not for children, but for teachers. Your reviewer truly says:—"Country life is a vast subject, so vast that no child can learn during his school life even a fraction of the information it may be desirable he should possess," and the same remark may be equally well applied to teachers. This book travels over much the same ground as "Reader" No. 1, but the matter is differently treated. In one case simplicity of language is aimed at, in the other the information is condensed, with a view, as it appears to me, of leaving it to the discretion of individual teachers to use such lessons, or portions of each lesson, as are most suitable to their own districts.

I do not wish wrongly to attribute ideas to the joint authors, but I fancy their intention is to put before rural teachers (many of whom have had little or no country training) as complete a summary as possible, taking it for granted that they would be able to pick out and study the essential parts.

This series of agricultural Readers and Lessons will, I think, do much to create a love of country life, may even help to counteract the attractions of town life. Rural depopulation is one of the most serious problems of the day, and if these books will assist, in only a small way, to arrest this migration, I feel sure you will not detract from their value by a few words which were probably due to a pardonable oversight.

A. H. H. MATTHEWS, Secretary.

Central Chamber of Agriculture, Broad Sanctuary Chambers, 20 Tothill Street, Westminster, S.W., September 30.

MR. MATTHEWS has hardly grasped the point of our notice—that Messrs. Buchanan and Gregory's book approaches the subject in the wrong spirit. The teacher is provided with a mass of indifferently selected information about farming matters, which he will pass on to his class instead of trying to lead it to observe and reason on its own account. The latter process is more difficult, but it happens to be education. We have of late had only too many occasions to deplore the "rural teachers with little or no country training," who hand out "condensed information" from little books about the country. It is this kind of instruction which offends both farmers and educationists, and if Mr. Matthews imagines it is going to counteract the attractions of town life and arrest rural depopulation, we can only hope that on this occasion he does not represent the opinion of the Central Chamber of Agriculture. THE REVIEWER.

CRATER LAKE IN OREGON.[1]

TWENTY years ago, as Mr. Diller informs us, this picturesque record of a strange episode in volcanic history was unknown to any but the Indians. It is still not very accessible, for it lies in an unfrequented region, deep set in the summit of the Cascade Range, some sixty-five miles north of the California line, but the United States Government, "recognising its worth as an educational feature," has already wisely secured it from the speculator and spoiler by making it a national park. An area of two hundred and fifty square miles is thus protected, of which we find a description in the present memoir. The first part, by Mr. Diller, deals with the geology and physical history of the great volcano, named after a local society Mount Mazama, which was shattered to form Crater Lake, and the second, by Mr. Patton, discusses the petrography of its rocks. It was virtually discovered by Captain Dutton, by whom and by Mr. Diller it has already been noticed; the U.S. Geological Survey has also published a special map, but the story is now completed in this excellently illustrated memoir.

The Cascade Range is largely, if not wholly, built up of volcanic material. In Cretaceous times it had no existence, "there flowed the sea"; this retreated during the Eocene, when vents opened in the Coast Range region, possibly also, though that is not yet quite certain, on the site of the Cascade. Here, however, volcanoes were in full activity during the Miocene, and built up a large part of the Range, where eruptions have continued almost to the present time. Post-Glacial outbursts occurred in some places, but seem to have ceased before history began, though hot springs and fumaroles show that the subterranean hearths are not yet cold. Some of the peaks rise above 10,000 feet, Mount Rainier even attaining 14,525 feet, and the surface of Crater Lake is rather more than 6200 feet above sea-level. It is an oval basin between twenty and twenty-one square miles in area, surrounded by cliffs which range from more than 500 to nearly 2000 feet in height, the ground falling more gradually from their rim to the present upland level. This great sheet of blue water, in places almost 2000 feet deep, is interrupted near its western margin by a pyramidal rocky mass, called Wizard Island, itself evidently a volcanic vent, and a study of the enclosing walls of the great caldera proves them to be built up in the usual way by ash-beds and lava-flows, dipping outwards from its axis, and riven by occasional dykes. The exterior slopes are dotted by parasitic cones, and exhibit occasionally moraines and Glacial striæ; they are also furrowed by valleys, which in some cases run up to and actually notch the edge of the cone, so that they evidently cannot have been formed on Mount Mazama as it now exists. They, like it, have been truncated, and the bowl occupied by Crater Lake has been formed by the destruction of a volcanic cone which must once have risen some six thousand feet above its present rim. Of this there can be no doubt; it is substantiated by numerous facts cited in this memoir, and we have only to study the geological map which it contains to see that the present lava streams are merely remnants of those discharged from sources at a greater elevation and nearer the central axis of the cone.

But the precise mode in which the upper part of the original Mount Mazama was destroyed, and Crater Lake formed among its ruins, is not quite so certain. Two explanations are possible. All the upper part of the mountain may have been hurled in shattered fragments through the air by a series

[1] "The Geology and Petrography of Crater Lake National Park." By Joseph Silas Diller and Horace Bushnell Patton (U.S. Geological Survey). Pp. 168. Plates i–xix. (Washington, 1902.)

of tremendous explosions, like those which truncated Papandayang in Java and shattered Rakata in Krakatoa, or the cone may have collapsed and been engulfed; mother earth, like the fabled Saturn, devouring her own offspring—which has happened on a smaller scale at Kilauea. Mr. Diller, after a discussion of the rival hypotheses, follows Captain Dutton in preferring the latter. Space does not allow of a full discussion of the reasons, but it may be enough to say that the explosive destruction of a great central cone might be expected to have piled up the fragments more or less symmetrically around the margin of the void; but, though much fragmental volcanic material has been scattered over not a few square miles of the surrounding region, this does not exhibit any such arrangement, and its presence may be explained by eruptions posterior to the formation of the caldera, such as that which built up Wizard Island. It must, however, be admitted that such a vast engulfment seems to demand the withdrawal of a corresponding quantity of lava from beneath the cone, and its discharge—as in the Kilauea eruption of 1840—from some distant vent, of which at present no evidence has been found. It is thus possible that each hypothesis is in part correct, for engulfment and explosion may have cooperated in the work of destruction, vast blocks of the ruined cone tumbling inwards to be blown out in shattered fragments and distributed over many miles of country—so that the volcano practically became an automatic muzzle-loader. But that Mount Mazama was not destroyed merely by an explosion like that of a colossal powder magazine, seems to be evident.

FIG. 1.—Western Border of Crater Lake with Wizard Island.

In the second part of the memoir Mr. Patton gives us a careful petrographical study of the materials of Mount Mazama. They are mostly, as is so usual with the volcanoes of the great mountain chains of the two Americas, andesites, among which the hypersthene-bearing varieties are common, though on the one hand dacites, and on the other basalts, are to be found. Full descriptions of these and their included minerals are given, as well as of certain portions of a rather different mineral character, which Mr. Patton regards as secretions. It is difficult to form an opinion without an actual study of the rock specimens and slices, but we venture to suggest that they may rather be inclusions—that is, to say, material which, though it may have been originally separated by some kind of differential action, and might so far be called a secretion, owes its present position to being caught up and carried away by the general mass of molten material. This, however, is a very small criticism. The memoir is a most valuable one, and its printing and illustrations maintain the usual high standard of the publications of the United States Geological Survey.

T. G. BONNEY.

THE BRUSSELS AND TERVUEREN MUSEUMS.

FOR many years past the Royal Brussels Museum of Natural History has presented attractions for the vertebrate palæontologist which can be rivalled by few and excelled by none of the institutions of a similar nature in Europe. But those who have not had an opportunity of seeing the collections recently will scarcely fail to be surprised at the vast increase which has been made in the exhibited series, and at the excellent manner in which the specimens are displayed even in the limited space at present available. A still greater degree of astonishment, and, we may add, of admiration, will be expressed by the visitor when he is shown the new buildings, now nearing completion, designed for the housing of the entire recent and fossil fauna of the country.

When the present writer (some twelve or fifteen years ago) last saw the collection, only a single skeleton of the far-famed Bernissart iguanodons was mounted in the exhibition galleries. Now there are no less than five such skeletons set up in their natural posture, while a sixth is shown lying on a mass of Wealden rock as it was exhumed from the quarry. A more magnificent display than the one presented by the skeletons of these mighty dinosaurs can scarcely be imagined.

Next in importance to the unrivalled iguanodons and associated reptiles from the Bernissart Wealden may probably be ranked the magnificent series of mosasaurian remains which have been obtained in working the phosphatic beds of the Upper Cretaceous strata of the Maastricht district and other parts of the country. In addition to several more or less imperfect skulls and other parts of the skeleton of the typical Mosasaurus, the collection includes remains of several other generic types, some of which, such as Hainosaurus, are peculiar to Belgian territory. Unlike so many European fossil vertebrates of large size, most or all of these generic types are represented by skeletons so nearly perfect as to admit of their being set up like those of recent animals. One of the treasures of the museum is the skeleton of the fore-paddle of a representative of these gigantic marine lizards, this specimen being believed to be the only known example of this part of the mosasaurian skeleton hitherto discovered in Europe. Another noteworthy specimen in this group is the skull of Prognathosaurus, remarkable for the exquisite state of preservation of the bones of the elongated muzzle. The turtles of the Upper Cretaceous, as represented by the well-known *Chelone hoffmanni*, and a still more gigantic unnamed species characterised by the extreme flatness of the carapace, likewise form a large and interesting exhibit.

Much more might be written about the Mesozoic vertebrates, but, from exigencies of space, it must

suffice to refer to an imperfect skeleton of *Plesiosaurus homalospondylus*, and another of *Ichthyosaurus platyodon* from the Lias of Luxembourg. The special interest attaching to these specimens is that, unlike the majority of "halosaurians" from the English Lias, the bones are separate, so as to admit of the skeletons being mounted after the fashion of the Oxfordian plesiosaurs in the British Museum.

Turning to Tertiary fossils, the magnificent series of cetacean remains from the Pliocene of Antwerp is too well known to need more than passing reference. Special attention may, however, be directed to the beautifully preserved skulls of long-nosed dolphins (Eurhinodelphis) from the Miocene deposits of the same locality, which have been recently described by Dr. Abel, and are some of the most interesting of all cetacean fossils. Neither is the collection lacking in valuable remains of sirenians, one case containing no less than five more or less imperfect skeletons of a representative of the widely spread Oligocene genus Halitherium, while in a second is displayed the skeleton of the body of an allied Miocene type, for which Monsieur Dollo has proposed the name of Miosiren. Evidently a large and specialised form descended from Halitherium, this genus is characterised by the enormous stoutness and solid structure of the ribs, which are so close together as to simulate a massive carapace in the region of the thorax. The specimens of the rhynchocephalian Champsosaurus, from the Lower Eocene, are likewise unique treasures of the collection.

The collection of remains from the cavern and other Pleistocene deposits forms another striking feature of the museum. Among the mounted specimens are three skeletons of the cave-bear, one of the cave-lion, and three of the woolly rhinoceros. The mammoth skeleton from a superficial deposit is one of the finest in existence out of Russia; while of especial interest is the imperfect skull of a very young individual of the same species, with the earlier milk-molars in position. A skeleton of the much rarer *Elephas antiquus* is likewise noteworthy, first, because the tusks are strongly curved, and, secondly, on account of the peculiar manner in which their tips are worn. This curvature of the tusks suggests that the title of straight-tusked elephant, which has been proposed for this species, is not so diagnostic as it might be. As regards the tips of the tusks, each has been ground into a blunt wedge—a mode of wear never observable in those of either the Indian or African species, and the cause of which is at present inexplicable.

Owing to lack of space, the fossil collections are now mingled with the series of skins and skeletons of recent animals in a manner calculated to confuse the non-scientific visitor, while at the same time the proportions of many of the specimens are not so well displayed as is desirable. All this, however, will soon be remedied, for the magnificent new wing, destined to contain the entire collection of indigenous Belgian animals, is, as already mentioned, fast nearing completion, the whole of the building itself being finished. A notable feature is the entire absence of any architectural decoration in the interior, a feature which might advantageously have been adopted in our own museums. The main hall of this magnificent building is no less than 100 metres in length by 30 in width. The floor is on four different levels, rising in terraces one above the other from the entrance. On the entrance level will be arranged the recent and Quaternary vertebrates (other than fishes); on the first terrace the Tertiary vertebrates, on the second the Upper Cretaceous vertebrate fauna, and on the third and highest the iguanodons and other reptiles of the Wealden. The visitor will thus obtain a *coup-d'oeil* of the whole effect immediately on entering. The iguanodons will be represented by no less than thirteen skeletons, of which nine are to be mounted and erect, while the remainder are to occupy a large tank-like excavation in the floor, in which they are to lie as in their native quarry. In the gallery running round this hall are to be arranged the recent and fossil fish-fauna of Belgium, while the invertebrates are to be housed on the floor above. By an ingenious arrangement of details, space has been found for a numerous series of large and well-lighted work-rooms. Some idea of the lavish scale on which the new building is planned may be gathered from the fact that the space available for the display of the Belgian fauna alone is four times as great as that allotted in the Paris Museum to the fossil vertebrate fauna of the whole world.

Eventually, I am told, it is hoped that a similar wing may be built on the opposite side of the museum for the exhibition of the fauna and products of the Congo Free State. At present the large collection from that territory (which is the private property of King Leopold) is housed at Tervueren, reached by a tram-ride of about fifty minutes from Brussels. In addition to many interesting anthropological and ethnological objects, the collection contains a fine mounted pair of okapis, as well as numerous antelopes and other representatives of the mammalian fauna of the Congo State, not to mention specimens of the birds, reptiles, fishes, and lower forms of life.

R. L.

TECHNICAL EDUCATION AND INDUSTRY.

THE national importance of a close and strong relationship between science and industry is shown by Sir William Ramsay in a letter in Monday's *Times*. Two points upon which emphasis is laid are that numerous scholarships awarded by county councils represent an expenditure of public funds which can do little to promote industrial progress, and that our manufacturers offer few openings for men who have received a sound and scientific education. Technical education, as it is understood in this country, and as most of our technical schools are compelled to understand it if they wish to obtain students, consists of lectures on the rudiments of science, illustrated by practical work of a very elementary kind. It is scarcely necessary to say that the training thus received is of little value to the students or to the community in comparison with the work carried on in the technical high schools of Germany. Sir William Ramsay recently had an opportunity of conversing with the manager of a large chemical works in Germany, which manufactures no product of which it sells less than 100 tons a year, and he directs the attention of our manufacturers to the following facts as to the connection between science and industry in Germany.

The company has seventy chemists, of whom twenty are employed in analysing the raw materials and intermediate and finished products; twenty-five are engaged in superintending the processes of manufacture; and the remaining twenty-five are exclusively employed in scientific work—*i.e.* in endeavouring to improve the present processes of manufacture, and in trying new suggestions, either their own, or those brought to the notice of the firm by patentees. Almost all these chemists have been trained in universities, but a few come from technical high schools or Polytechnika. It is common for the best of such men to receive a "call" to a chair in a university or a Polytechnikum, and it is also usual for a company to offer a lucrative post to one who already holds a chair, even though he may have had no technical experience, and in this way a close bond has been

established between science and industry to the enormous advantage of both.

A large part of the duties of the director consists in attending congresses and in every way keeping abreast of the most recent discovery, with the object, of course, of gaining information which may be turned to practical utility.

While in Germany there is thus a fairly lucrative career for a young chemist, in England, although there will soon be many well-trained men, the openings are few. Such as there are are filled by men whose minds are occupied with too many things. The chemist is often analyst, works-manager, and investigator all at once; and it is no wonder that he is not a success, and that manufacturers doubt his utility in their business. Moreover, it is very desirable that a closer touch between universities or university colleges and manufactures should be brought about, if possible, for it cannot fail to be to the advantage of both industry and science—to industry, in order that technical problems may receive scientific treatment, and to science, because some of the most interesting problems are often suggested by the technologist.

Now, we are producing trained engineers and chemists quite as inventive and capable as our German competitors. But the prospect of a reasonably remunerative career is generally wanting. It would obviously be to the advantage of manufacturers to engage such young men, not expecting them, of course, to be able at first to introduce improvements which will effect a saving; but by looking out for young men with some originality, by giving them time to learn their business, and by offering an ultimate inducement in the shape of a share of profits, our manufacturers will undoubtedly reap the benefits which have given our German competitors their lead in industries in which chemistry plays a part.

NOTES.

AT the Institution of Civil Engineers on Tuesday, November 3, an inaugural address will be given by the president, Sir William H. White, K.C.B., F.R.S.; the medals and other awards made by the council will be presented, and there will be a reception in the library of the Institution.

MR. MARCONI arrived at Liverpool on board the *Lucania* last Saturday. The results of his experiments are said to have been very satisfactory; whilst in mid-Atlantic he was able to receive simultaneously communications from England and America. It is also stated that he hopes within six or eight months to re-establish commercial communication across the Atlantic.

THE trials of the high-speed electric cars on the Berlin-Zossen military line have been continued with much success. A maximum speed of 125½ miles an hour was attained by the Siemens-Halske car last week; the average speed over the whole run of 14 miles, including the time of starting and stopping, was 109½ miles an hour. The trials of the rival car, which the Allgemeine Elektricitäts Gesellschaft is building, have yet to be made. The track has been relaid since the experimental runs last year, and it is stated that it is now thoroughly satisfactory. The result of the trials is looked upon as demonstrating the practicability of high speed working over long distances, and it is estimated that it will be possible to reduce the time taken over the journey from Berlin to Cologne from nine to three and a quarter hours.

THE secretary of the Institution of Electrical Engineers informs us that the bronze shield subscribed for by the students of the Institution at the beginning of the present year has now been placed upon the tomb of Volta at Camnago, near Como. The ceremony of fixing it in place was performed on Sunday, October 4, with many expressions of international good feeling, in the presence of Prof. Count Alessandro Volta, Cav. Franchi, the Sindaco of Camnago, with several members of the Volta family and a number of other guests. The shield is mounted on a slab of green marble supported on granite in front of the tomb. The electrotype reproduction, which was officially deposited on the tomb on the occasion of the visit of the Institution in April last, has been transferred to the Civic Museum in Como, where it is placed in the collection of Volta relics.

DR. W. A. NOYES, of the Rose Polytechnic Institute, has accepted the position of chemist in the United States National Bureau of Standards.

DR. B. A. WHITELEGGE, C.B., His Majesty's Chief Inspector of Factories, has been appointed president of the Epidemiological Society in succession to the late Dr. W. H. Corfield.

AN International Fine Art and Horticultural Exhibition is to be opened at Düsseldorf on May 1, 1904. A hope is expressed that England will contribute largely to this exhibition.

REUTER reports that Prof. Langley's aërodrome, for which the U.S. Government granted a subvention of 15,000*l*., was launched on October 7 from the railway over the flat boat on Whitewater, a section of the Potomac River. The machine balanced perfectly when it started, but soon struck the water, with the result that it was wrecked. Previous experiments have been made with models only, and this trial was the first made with the full-sized airship, which is constructed to carry a passenger.

THE Home Counties Nature-Study Exhibition, which is being organised by the Middlesex Field Club and Nature-Study Society, and delegates from the Selborne Society, will be held from October 30 to November 3 at the offices of the Civil Service Commission, Burlington Gardens, London, W. Intending exhibitors should communicate with the honorary secretary, Mr. Wilfred Mark Webb, 20 Hanover Square, London, W., who will be pleased to supply full information.

WE learn from *Science* that the American Grape Acid Association, 318 Front Street, San Francisco, Cal., offers a premium of 5000*l*. for any person who devises a process or formula for the utilisation of California grapes containing more than 20 per cent. of saccharin, worth 2*l*. a ton, to produce tartaric acid at a price that would permit of exportation without loss. The decision in awarding the amount is to rest with a jury of five, of which Prof. E. W. Hilgard, of the University of California, is one. The offer closes on December 1, 1904.

THE first meeting of the Manchester Astronomical Society—a new local association of persons interested in astronomy and observational work—was held on Wednesday, October 7, when an address on solar parallax was given by the president, Prof. T. Gore. The Society has its centre and home in the Municipal School of Technology, Manchester, and members have the privilege of using the telescopes and other instruments in the new Godlee Observatory.

THE death is announced of Mr. Henry M. Brunel, the second son of I. K. Brunel, the engineer. Mr. Henry Brunel entered into partnership with Sir John Wolfe Barry in the 'seventies of last century, and took active interest in the scientific researches bearing upon naval architecture carried on by the late Mr. William Froude, F.R.S. He was largely associated in the work of Barry Dock, the railway bridge over the Thames at Blackfriars, the bridge erected at Connel Ferry, and with the Tower Bridge. He was a member of the Institution of Civil Engineers and of the Institute of Naval Architects.

AN excessive downpour of rain is reported from New York on October 8–9, amounting to more than ten inches in thirty hours. This is said to be the greatest fall at that place since the Weather Bureau was established there, in 1867, and has caused great damage to property. The streets resembled rivers, and in some parts the water rose waist-deep. The train service between New York and Philadelphia was temporarily suspended; the Delaware River rose to the highest level ever known, and several bridges have collapsed. Since 1889, the U.S. Weather Bureau has published tables of excessive rainfall from self-recording gauges. We have referred to these, and find that, although such excessive falls do occur from time to time, they are of rare occurrence. During the years 1889–1896, for instance, the highest record was 9·86 inches in twenty-four hours, at Jacksonville (Florida), in September, 1894.

WE have received the report of the director of the Philippine Weather Bureau, 1902, part iii., containing very clearly printed hourly observations of atmospheric phenomena at the Manila Central Observatory, with hourly and monthly means. The extreme daily values of each of the elements are brought together in a separate table. This is one of the few observatories at which observations of ozone are taken. Parts iv. and v. still remain to be published, and will contain magnetic observations and the results for the secondary stations of the Archipelago. The complete series will form a valuable contribution to the climatology of the Far East.

WE have received the report of the Hong Kong Observatory for the year 1902, containing hourly readings of the different meteorological elements, together with some magnetic and astronomical observations. The weather forecasts issued during the year have been very satisfactory; 56 per cent. were completely successful, and 35 per cent. partially successful. According to the practice usually followed in dealing with the results, 91 per cent. of the forecasts may be therefore considered as more or less successful. The collection of observations at sea for the construction of trustworthy monthly pilot charts has been vigorously continued; the number of days' observations obtained during the year was 9073, while the total number of sets now collected amounts to nearly 261,000. The area dealt with lies between 9° S. and 45° N. latitude, and between the longitude of Singapore and 180° east.

M. K. OLSZEWSKI describes in the Cracow *Bulletin* a new apparatus for the liquefaction of hydrogen, differing from his previous models in having both regenerators and the intermediate cooler for receiving liquid air all placed in a common vacuum chamber. The apparatus is said to work faultlessly.

THE formation of "Liesegang's rings" by the precipitation of silver chromate in gelatin forms the subject of a paper by Messrs. H. W. Morse and G. W. Pierce in the *Proceedings* of the American Academy. The formation of the precipitate in rings is clearly a case of supersaturation, and the authors now obtain a definite constant value for the product of the concentrations of the silver and chromate ions in order that supersaturation may take place.

SEVERAL papers on the so-called N rays discovered by M. Blondlot are printed in the *Journal de Physique* for August. M. Blondlot shows that these rays are of common occurrence, being emitted by an Auer lamp and an incandescent silver lamina, and being present in sunlight. M. G. Sagnac describes determinations of the wave-length of these rays by means of their diffraction. It appears that the rays in question are about two octaves below the Rubens infra-red rays, and intermediate between these and the Hertzian radiations of Lampa. Their wave-length is about 0·2 of a millimetre.

SEVERAL writers have raised difficulties in connection with Boltzmann's minimum theorem in the kinetic theory of gases on the ground of the reversibility of the motions of the individual gas-molecules. Some remarks on this point are contributed by Dr. A. Pannekoek to the *Proceedings* of the Amsterdam Academy. For the case considered the author finds that when in a purely mechanical reversible process, which is repeated a number of times, a small variation in the initial data causes a large variation in the final state, the total process assumes the properties of an irreversible process.

SOME observations made in the Arosa Valley on atmospheric electricity at high altitudes are described by Mr. W. Saake in the *Physikalische Zeitschrift*, 23. The most noteworthy results were the observation of a negative fall of potential on certain clear and cloudless winter days, the facts that the coefficient of electric dispersion of electricity was increased by the Föhn and that under normal conditions the coefficient of negative dispersion attained a maximum at about 8 a.m. and between 4 and 5 p.m., and the large capacity of the atmosphere for radio-active emanation, which was about three times as great as in Wolfenbüttel.

THE Hopkins-Stanford Expedition to the Galapagos Islands in 1898–99 turns out to have been remarkably successful in the matter of new species of marine fishes from that area. According to a paper by Messrs. Heller and Snodgrass, published in the *Proceedings* of the Washington Academy (vol. v. pp. 189–229), the number of novelties is twenty-three, of which no less than five are regarded as indicating new generic types. Most of the species are figured in the plates accompanying the memoir, and we may particularly direct attention to the excellent effect produced by the sepia-like printing of plates 8 and 9.

IN the October issue of *Bird Notes and News*, attention is directed to the power now possessed by county councils of extending protection during winter to birds of any kind, and the value of this to many resident species. The introduction last July into Parliament of a Bill to abolish the pole-trap is likewise the subject of a commendatory note. A letter from Colonel Irby, which appeared in the *Saturday Review* of July 18, on the subject of taking rare birds and their eggs for so-called scientific purposes is reproduced. In this communication the writer directs attention to the shooting of a pair of pratincoles last spring near Romney, and likewise to the taking of a nest of the blue-headed wagtail near Winchelsea.

THE *Century Magazine* for October contains an account by Mr. L. O. Howard of the recent investigations which have served to connect the propagation of yellow fever with a certain species of mosquito (*Culex aeniatus*). A map (after Mr. Theobald) is given of the distribution of this mosquito, which coincides exactly with that of yellow fever. To protect oneself from the malaria mosquito, it is only necessary to use gauze curtains at night; the yellow fever mosquito, on the other hand, is a diurnal species, so that escape from its stab is a matter of much greater difficulty. In a well-illustrated article in the same journal entitled "The Wild Bird by a New Approach," Mr. F. H. Herrick comments on the revival of interest in nature generally, and natural history in particular, which has taken place of late years in the United States. Birds have been specially

favoured in this respect, and the author directs attention to the amount of information with regard to their habits obtainable by the new method of photography at short distances, to which allusion has been previously made in these columns.

WE have received a copy of the eighth report on the periodic variations of glaciers, by Dr. S. Finsterwalder and E. Muret (*Arch. des Sc. phys. et nat., Genève*).

WE have received from the Queensland Department of Mines, Geological Survey Reports, Nos. 181 and 183, by Mr. Walter E. Cameron. The author deals with recent mining developments on the Ravenswood Gold Field, where rather more than 2 oz. 7 dwt. of gold per ton has been raised during the past three years. He also gives further particulars relating to coal, and gold, silver, and copper ores in the Mackay and Bowen districts.

PROF. W. M. DAVIS has sent us copies of two recent essays on earth sculpture (*Bull.* Mus. Comp. Zool., Harvard Coll., vol. xlii.). One deals with the plateau province of Utah and Arizona. Evidence is given to show that the greater part of the faulting had been accomplished before the uplift of the region by which the erosion of the Colorado canyon was initiated, but some modern faulting of large amount has taken place. The other essay is on the mountain ranges of the Great Basin, in which the author deals with the effects of erosion on faulted mountain-blocks.

THE surface geology of Cheshire in its relation to agriculture is dealt with by Mr. William Edwards (*Proc.* Liverpool Geol. Soc., vol. ix. part iii.). He refers to the Drift soils, but more especially to those derived from Triassic rocks. The Keuper Marls yield some of the best soils, owing to their mineral ingredients, to their physical properties, and in part to their colour. The author observes that most of our best soils have a deep red colour, and probably the value of this colour depends upon its power to absorb the heat rays of the sun.

THE general report of the work carried on by the Geological Survey of India for the year 1902–1903 has been drawn up by the new director, Mr. T. H. Holland. Economic inquiries have been made with regard to coal, chromite, fire-clay, gold, iron, manganese, lead, petroleum, &c. Field-work was carried out in seven districts. In the report on the Punjab area, reference is made to evidence brought forward by Dr. Noetling, that in the Salt Range the sedimentary series from Cambrian to Tertiary has been thrust bodily in a southerly direction over the salt-marl, and that the marl is not pre-Cambrian, but simply belongs to the Tertiary salt-bearing formation, like that represented at Kohat.

WE have received from Messrs. Darbishire and Stanford, of the Oxford Geographical Institute, Oxford, specimens of a new series of outline maps which they are issuing under the title of the "Autograph Handmaps," at the price of one penny each. The feature of the series is that, besides showing the coast lines and the principal rivers, the chief hill features of the country are indicated by a very expressive scheme of shading, which renders the pictorial value of the maps, and therefore their value in elementary teaching, decidedly greater than is the case where contour lines are employed. The execution is somewhat unequal, but generally good; the maps of the British Isles, Scotland, and Ireland are the best. We note that in most cases the name of the projection on which the map is drawn, the natural scale, and scales of miles and kilometres, are given. The maps are printed in a dull brown colour, so that additional matter introduced by teacher or pupil stands clearly out. The maps are a valuable addition to the equipment available for teaching geography, and as such should be heartily welcomed.

IN the Cracow *Bulletin*, Mr. Ed. Janczewski proposes a new classification of the species belonging to the genus Ribes. The author distinguishes six subgenera, four of which (Ribesia, Berisia, Grossularioides, and Grossularia) are characterised by scarious scales, while in the other two (Calobotrya and Coreosma) the scales are herbaceous.

THE early cell divisions in the germinating spore of the liverwort Pellia form the subject of a paper by Mr. C. J. Chamberlain in the *Botanical Gazette*. As Prof. Farmer originally showed, interest attaches to the nuclear divisions at this stage owing to the appearance of a centrosphere and radiations. Mr. Chamberlain holds the opinion that the radiations represent lines of streaming material.

IT is known that the red and blue colours of many flowers and fruits are due to the pigment anthocyanin, which occurs in the cell sap. Mr. T. Ischimura has examined its formation in hydrangea flowers, and describes the results in the *Journal* of the College of Science, Tokio. In conformity with the reactions obtained the author concludes that anthocyanin is a tannin, or a tannin derivative, and shows that besides tannin, light, and generally sunlight, is necessary for its formation.

IN the report for the year 1902–3, the director of the Botanical Survey of India announces the retirement of Mr. J. F. Duthie, who held the post of director of the Botanical Department of Northern India. The investigations of the various kinds of Indian yams are being continued, and cultivations of fibre plants are being undertaken in order to determine the sources of the fibres classed as Indian hemp. Mr. C. A. Barber refers to a disease known as "spike" which is destroying the sandal wood plantations of Mysore and Coorg, and also reports the appearance of a species of fungus on cholam leaves, similar to one which is very destructive to the sugar cane.

A USEFUL little book on "Hardy Perennials," by Mr. D. S. Fish, has been published in the Rural Handbook Series by Messrs. Dawbarn and Ward, Ltd. Amateur gardeners will find in the book practical hints on the selection, arrangement, and cultivation of many hardy garden flowers.

MESSRS. ROSS, LTD., have issued recently an abridged catalogue for 1903, and a new edition of their "C" catalogue. Both lists are beautifully illustrated with reproductions of photographs taken with Ross, Ross-Zeiss, and Ross-Goerz lenses, and contain full information of photographic and other optical apparatus.

WE have received a second edition of the discourses by Dr. Stephan Waetzoldt bearing the title "Die Jugendsprache Goethe's" and "Goethe und die Romantik," the first edition of which was printed in 1888. An addition has now been made in the form of a third discourse dealing with the ballads of Goethe and their origin.

ALL photographers will find something of value and interest in the first number of the *Practical Photographer*—that for October. Not only is photography regarded from

its scientific side by chemists and others, but the artistic aspects of the photographer's work are dealt with in a helpful manner by experienced writers. The magazine is admirably illustrated by a profusion of well executed plates, and is published by Messrs. Hodder and Stoughton.

MESSRS. F. E. BECKER AND Co., of Hatton Wall, London, are manufacturing cheap electric switchboards for use in physical laboratories supplied with continuous current, designed by Mr. William Bennett, of the Gravesend Technical School. It is claimed that by this method it is impossible for students to short circuit the mains, as only one wire is carried round the room. A switch block is provided in each working place, and all students have the same current, but any student can switch the current on or off without interrupting others. The boards are supplied with resistances, instruments for measuring current, and other necessary adjuncts.

WE have received the thirty-sixth volume, that for 1902, of the *Journal and Proceedings* of the Royal Society of New South Wales. The original papers contained in the first part of the volume are seventeen in number, and many of them are illustrated by plates, of which there are no less than twenty-one. The volume concludes with the annual address delivered to the engineering section of the Society, and two papers also read to the same section. As abstracts of the papers read before the Society are periodically published in NATURE, it only remains to be said that the scientific work of the Society, as represented by the contents of the volume before us, does honour to the colony of New South Wales.

THE additions to the Zoological Society's Gardens during the past week include two Black Lemurs (*Lemur macaco*) from Madagascar, presented by Mr. Walter Barnes; a South African Hornbill (*Bucorvus cafer*) from South Africa, presented by Mr. W. Champion; two Larger Patagonian Conures (*Cyanolyseus byroni*) from Chili, presented by Mr. E. C. Davids; two Grey-winged Ouzels (*Merula boulboul*) from India, an Adelaide Parrakeet (*Platycercus adelaidae*) from Australia, three Derbian Sternotheres (*Sternothaerus derbianus*) from West Africa, two Adorned Terrapins (*Chrysemys ornata*) from Central America, four Brazilian Tortoises (*Testudo tabulata*), four Orbicular Horned Lizards (*Phrynosoma orbiculare*) from Brazil, deposited.

OUR ASTRONOMICAL COLUMN.

REPORTED DISCOVERY OF A NOVA.—A telegram received from the Kiel Centralstelle on October 5 announced that Prof. Wolf had discovered what was probably a new star on the evening of September 21. He found the position of the object, reduced to the equinox of 1903, to be R.A. = 20h. 14m. 6·8s., Dec. = $+37^\circ\ 9'\ 49''$, and reported that its spectrum was of the nebular type.

A further communication received from Kiel announces, however, that a telegram received from Prof. Pickering states that the object is not a Nova, but a variable having a spectrum of the fourth type, whilst another telegram from Prof. Hale announces that Barnard has identified the supposed Nova with the star B.D. $+37^\circ$·3876 (R.A. = 20h. 14m. 6.8s., Dec. = $+37^\circ\ 9'\ 47''$), and found the colour to be "very red." Dr. Parkhurst determined the magnitude of the variable on October 5, and found it to be 10·6.

1903–4 EPHEMERIS FOR WINNECKE'S PERIODICAL COMET.—The elements and ephemeris of Winnecke's comet for its appearance during 1903–4 have been calculated by Herr C. Hillebrand, of Graz, and are published in No. 3907 of the *Astronomische Nachrichten*. The elements and part of the ephemeris are given below:—

Epoch = 1904 *Jan.* 24·0 (M.T. *Berlin*).

$$M = 0^\circ\ 28'\ 1''\!\cdot\!61$$

$$\left.\begin{aligned} \pi &= 274\ \ 19\ 45\cdot40 \\ \Omega &= 104\ \ 12\ 36\cdot44 \\ i &= 16\ \ 59\ 54\cdot78 \end{aligned}\right\} 1903\cdot0 \qquad \begin{aligned} \phi &= 45^\circ\ 38'\ 0''\cdot12 \\ \mu &= 608''\cdot801706 \end{aligned}$$

Perihelion = 1904 Jan. 21·24

Ephemeris 0h. (*M.T. Berlin*).

1903	α app. h. m. s.	δ app. ° ′ ″	log r	log Δ
Nov. 1	13 35 54·28	+1 11 47·0	0·166981	0·374761
„ 3	13 41 49·41	+0 35 3·6		
„ 5	13 47 50·73	−0 2 5·9	0·155366	0·366226
„ 7	13 53 58·38	−0 39 40·7		
„ 9	14 0 12·47	−1 17 39·6	0·143512	0·357652
„ 11	14 6 33·07	−1 56 2·0		
„ 13	14 13 0·47	−2 34 46·1	0·131432	0·349133
„ 15	14 19 34·92	−3 13 50·8		
„ 17	14 26 16·54	−3 53 13·8	0·119153	0·340701
„ 19	14 33 5·45	−4 32 53·3		
„ 21	14 40 1·91	−5 12 46·9	0·106706	0·332417
„ 23	14 47 6·18	−5 52 52·6		
„ 25	14 54 18·36	−6 33 7·1	0·094136	0·324344
„ 27	15 1 38·61	−7 13 27·7		
„ 29	15 9 7·05	−7 53 50·7	0·081493	0·316550

DIAMETER OF NEPTUNE.—Herr C. W. Wirtz, Strassburg, publishes the results of a series of measurements of the diameter of Neptune, made by him during the period December, 1902–March, 1903, in No. 3907 of the *Astronomische Nachrichten*. As the mean result of forty-nine measurements, made on twenty-six evenings, he obtained 2″·303 with a possible error of ±0″·044 for the value of the diameter.

Taking the value of the solar parallax as 8″·80, and Bessell's dimensions for the earth, this gives the actual diameter of Neptune as 50,251 km. and the mean density of the planet as 1·54, the density of the earth being taken as 5·53.

THE OPPOSITION OF EROS IN 1905.—In No. 73 of the Harvard College Observatory *Circulars* Prof. Pickering publishes an ephemeris for Eros during the opposition of 1905.

This ephemeris gives the Julian Day, the date, the R.A. (1900) and Dec. (1900), the logarithms of the distances from the sun and earth respectively, and the computed magnitude for every tenth day from November 21, 1903, to December 20, 1905; it has been obtained by interpolation from an ephemeris, for intervals of forty days, computed by Mr. F. E. Seagrave from the elements published in the *Berliner Jahrbuch* for 1905.

As seen from the ephemeris, the opposition of Eros during 1905 will be one of the most unfavourable oppositions that can possibly occur, for the computed magnitudes never exceed the twelfth. Prof. Pickering recommends that observations of the light variations, both photographic and visual, should be made during the opposition, although Prof. Bailey, working with the 13-inch Boyden telescope at Arequipa during the present year, has obtained an excellent set of light-curves of this planet. In general the position of the planet in the sky, during the 1905 opposition, will be nearly opposite to that which it occupied during the spring of 1901, when its variability was discovered.

THE ROYAL UNIVERSITY OBSERVATORY, VIENNA.—The sixteenth annual volume of the Vienna Observatory *Publications* contains the details of the "zone observations" for the zone −6° to −10°, made in accordance with the programme of the Astronomische Gesellschaft for its star catalogue, and collected by Dr. Johann Palisa. The observations were made with the 11½-inch Clark refractor, and the tables give the position for 1875·0, together with the usual reductions.

The same instrument was also used by Herr J. Rheden for observing the opposition of Mars during the period December 21, 1898–March 16, 1899, and the results of these observations, including eight excellent coloured reproductions of Herr Rheden's drawings, form the second part of the publication.

The third and last section is devoted to the meteorological observations made during the years 1897, 1898, 1899 and 1900.

THE BRITISH ASSOCIATION.

SECTION L.

EDUCATIONAL SCIENCE.

Opening Address by Sir William de W. Abney, K.C.B., D.C.L., D.Sc., F.R.S., President of the Section.

The Section over which I have the honour to preside deals with every branch of education. It is manifest that in an Address your President cannot deal with all of them, and it remained for me to choose one on which I might remark with advantage. As my official work during the last thirty-three years has been connected with education in science, I think I cannot do better than take as my subject the action that the State has taken in encouraging this form of education, and to show that through such action there has been a development of scientific instruction amongst the artisan population and in secondary day schools. The development may not indeed have been to the extent hoped for, but it yet remains that solid progress has been made.

I have chosen the subject deliberately, as I find that there are very few of those who have the interests of education strongly at heart, or who freely criticise those who have borne the burden of the past, that have any knowledge of the trials and difficulties (some of its own creating, but others forced on it by public opinion) which the State, as represented by the now defunct Science and Art Department, had to contend with in its unceasing missionary efforts in the cause of scientific instruction. I shall not attempt to do more than show that whatever its defect may have been in tact, whatever its shortcomings in method, that Department still deserved well of the country for the work that it did in regard to the fostering of scientific instruction in the country at large.

As far back as 1852 the Government of the day, influenced very largely by the Prince Consort, realised that it had an educational duty to perform to the industrial classes. Whether it was influenced by philanthropic motives or from the evidence before it that if Great Britain was to maintain its commercial and industrial supremacy scientific instruction was a necessity, it matters little. The fact remains that it determined that the industrial classes should have an opportunity of acquiring that particular kind of knowledge which would be of service to them as craftsmen. In this year 1852 the Speech from the Throne contained these words: "The advancement of Fine Arts and of Practical Science will be readily recognised by you as worthy of a great and enlightened nation. I have directed that a comprehensive scheme shall be laid before you, having in view the promotion of those objects towards which I invite your aid and co-operation."

It is somewhat remarkable that the then Ministry, of which Lord Derby was the chief and Mr. Disraeli the Chancellor of the Exchequer, did not survive to promulgate the scheme, which proposed theoretical rather than practical science, but that their successors, under Lord Aberdeen, issued it and commenced to carry it into effect. In 1853 the Department of Science and Art was established under the direction of Mr. Cole. Since 1835 so-called Schools of Design had been in being. These came under the new Department, and it was determined to establish science classes for instruction in science, Dr. Lyon Playfair, the well-known chemist, being charged with the duty. Playfair resigned in 1858, and in 1859 Mr. Cole induced a young Engineer officer, Lieut. Donnelly, to undertake the inspection and organisation of science instruction throughout the country. It was through this officer's untiring energy and zeal that the classes in science flourished and were added to at this early stage of the new Department's history. The same energy was displayed by Donnelly during the whole of his long career in the service of the State, and I feel that it was fortunate for myself to have served so many years as I did under one to whom the country at large owes a deep debt of gratitude.

Not long ago he passed away from us, and there will be no more lasting memorial to him than that which he himself erected during his lifetime in the fostering of that form of education which is of such vital importance to the national well-being.

To revert to history, I may record that the first science examinations conducted by the State took place in May, 1861, and, the system of grants being made on the results of examination having been authorised, the magnificent sum of 1300*l.* was spent on this occasion on the instruction of 650 candidates, that number having been examined. Thus early was the system of examination commenced in the Department's career, and the method of payments on the results of these examinations stereotyped for many years to come. There is reason to believe that the educational experts of that day considered that both were essential and of educational value, a value which has since been seriously discounted. Employers of labour in this country were not too quick in discerning the advantages that must ultimately ensue from this class of education if properly carried out and encouraged. Theoretically they gave encouragement, but practically very little, and this survives to some extent even to the present day. Some of the foremost employers, however, gave material encouragement to the formation of classes, insisting on their employees attending evening instruction; but conspicuous above all was Mr. Whitworth, who, in 1868, placed in the hands of the Department the sum of 100,000*l.*, to be devoted to the creation of scholarships, which were to be awarded at the annual May examinations. The proviso made by him was that all competitors were to have had experience in practical work in an engineering establishment. Such candidates, it was evident, must have found out their own weakness in education, and, by working in science classes, could make up their deficiencies, and the award of these scholarships would enable them to study further. Sir J. Whitworth was far-seeing and almost lived before his age, but the benefits that he has conferred, not only on individuals, but on science and industries, by his generosity will make his name to be remembered for generations to come. To have been a Whitworth scholar gives an *entrée* into various Government and engineering posts, and we have in the front rank of science men who have held these scholarships and whose names stand prominent in the development of engineering.

Incidentally, I may say that no country but this, for very many years, considered that instruction in science for the artisan was a large factor in maintaining and developing industry. The educational interests of the employer and the foreman were, in some countries, well provided for, but the mechanic was merely a hand, and a "hand" trained in merely practical work he was to remain. He could not aspire to rise beyond. We may congratulate ourselves that such a "caste" system does not exist amongst ourselves.

For the first twenty-five years of the Department of Science and Art the grants given by Parliament for science instruction were distributed almost entirely amongst those who were officially supposed to belong to the industrial classes, and no encouragement was offered to any higher class in the social scale.

It would take me too long to show that at first the industrial classes were very shy of seizing on the advantages offered them. Suffice it to say that they had to be bribed by the offer of prizes and certificates of success to attend instruction, and it was not for several years that the evening classes got acclimatised and became popular.

The evening instruction was then largely attended by adults. That this was the case may be judged by the fact that the average age of candidates who obtained successes in advanced chemistry was about twenty-five and in elementary chemistry about twenty-one. I have alluded to the apathy displayed by employers and by the artisans in the early days of the Department of Science and Art. The causes which dispelled it in both employers and employed, in regard to science instruction, will be found in the following extract from a report by the Department of Science and Art:—

"The Paris Exhibition (1867) caused the work of this country to be brought into close comparison with that of the rest of the Continent, and in many points both of manufacture and of skilled labour it was found England did not stand in such a good position as she had done a few years back. Dr. Playfair, in a letter to the *Times*, drew attention to this, attributing much if not all the evil to the deficiency of our technical education among the artisan class. The substance of this letter was taken up by many

persons of influence during the autumnal recess, and it led to a sort of educational panic, the cry for technical education becoming quite the absorbing topic among all circles and forming a considerable portion of the contents of all periodicals. Meetings were convened and addresses delivered all over the country, and the question was so much ventilated that important changes were anticipated in the educational arrangements of the country during the coming session of Parliament, which unfortunately were put off on account of the debates on the Reform Bill of 1868.

"The agitation necessarily brought forward the work of the Science Division of the Science and Art Department, and it is not a little remarkable how completely the system which had been growing up since 1860 seemed to meet all the requirements of the case, and at the same time how few persons had any idea of its provisions in spite of all that had been done to spread a knowledge of the scheme.

"There can be no doubt, however, but that this six years' work had silently, though materially, effected a change in the general tone of feeling on the subject of scientific education, and had been the means of preparing the country for the 1867 agitation. The different feeling among the working-classes on the subject is forcibly shown in the Annual Report of the Science and Art Department. From this it appears that in 1860 a pupil in one of the science classes in Manchester, a town usually looked upon as in advance of others, could hardly continue his attendance at the class owing to the taunts of, and ill-treatment by, his companions. Nevertheless, in the autumn of this year, 1867, hardly enough could be said or done to satisfy the desire for science classes being formed for those very persons who, but six years before, had considered attendance at a Government science school as almost against the rules of their trade."

Such was the account of 1867 given by Mr. G. C. T. Bartley (now Sir G. Bartley, M.P.). The plan adopted by the Science and Art Department for encouraging instruction in science was perhaps the best that could be devised at the time, though we now know that it was capable of improvement. It may be mentioned that an improvement in it was made the next year by the introduction of a very large system of scholarships, scholarships which have enabled the possessors in some instances to continue their studies at universities, and several distinguished men owe their positions to this aid. It was in this same year that Mr. Whitworth established his scholarships, as before described.

I have endeavoured to give a brief *résumé* of what was done during the first fifteen years of the existence of the Science and Art Department, and it continued to expand its operations after 1868 on the same lines for another ten years. In 1876 your President became connected with the Department as a Science Inspector. I am sure the Section will forgive me if I am somewhat personal for a few moments. During the previous eight years I had had the honour of being a teacher of some branches of physical science at the School of Military Engineering, and my own training was such that I had formed a very definite opinion as to how science instruction should be imparted, both to those who had a good general education and also to those who had not. The method was the same in both cases: it should be taught practically. I may say that though I had not myself had the advantage of being taught it at school, I had learned all the science I knew practically, and I entered the Department fully impressed with this view. Whenever possible I have until the present time endeavoured to impress this view on all who were interested in the work of the Department. Much of the science that was taught in State-supported classes was largely book work and cram, and the theoretical instruction as a rule was unillustrated by experiment. This was undoubtedly due to the system of payments being based on success at the examinations. I must here say that there were honourable exceptions to this procedure. There were teachers, then as now, who knew the subjects they taught, and who were inspired by a genuine love of their calling. I can in my mind's eye recall many such, some of whom have joined the majority and others who are still at work and as successful now as then in rousing the enthusiasm of their students.

I am not one of those who think, as some do, that cramming is entirely pernicious. A good deal of what used to be taught at public schools in my days was cram. It served its purpose at the time in sharpening the memory, and was a useful exercise, and it did not much matter if in after years much of it was forgotten. If the cramming is in science, a few facts called back to mind in after life are better than never having had the chance at all. In fact, as the faded beauty replied to the born plain friend, it is better to be one of the "have beens" than a "never wasn't."

It was determined to make a vigorous onslaught against teaching that was unillustrated by experiment and to encourage practical teaching as far as could be done. Proper apparatus for illustrating lectures was insisted upon, and, with aid from the Department, was eventually provided, though in some instances several years' pressure had to be exercised before it was obtained. I am bound to say that in many instances after it had been procured a surprise visit by the inspector during the hours of instruction often found that the lecture table was free from all encumbrance, and that the dust of weeks was upon the apparatus that should have been in use. This was sometimes due to the inability of the teacher to use the apparatus rather than to a wish to disregard the rules laid down by the Department; but usually it was due to the fact that the teacher found cram paid best. I should like to say here that this state of things does not exist at the present time, and that the training of science teachers by the Royal College of Science and by other institutions has completely broken down the excuses that were often offered at that time.

The first grants for practical teaching were paid for chemistry. The practical work had to be carried out in properly fitted laboratories. There were not half-a-dozen at the time which really answered our purpose, and one of the earliest pieces of work on which I was engaged was in assisting to get out plans for laboratory fittings. These were very similar to those which I had designed for the School of Military Engineering several years before. Thanks to the Education Act of 1870 (I speak thankfully of the work that some of the important School Boards have done in the past in taking an enlightened view of science instruction) there were some localities where the idea of fitting up laboratories was received with favour, and it was not long before several old ones were refitted, in which instruction to adults was given, and new ones established in Board Schools for the benefit of the Sixth Standard children. At that time an inspector's, like the policeman's, lot was not a happy one. We had to refuse to pass laboratories which did not fulfil conditions, though we left very few "hard cases."

Until after the passing of the Technical Instruction Act in 1887 the Department aided schools in the purchase of the fittings of laboratories (both chemical and others), and year after year this help, which stimulated local effort, caused large numbers of new laboratories to be added to the recognised list. After six or seven years we had a hundred or more laboratories at work of what I may call "sealed-pattern efficiency." I am not very partial to sealed patterns, but they are useful at times, for they tell people what is the least that is expected from them. The pattern was not without its defects; but laboratories, like other matters, follow the law of evolution, and the more recently fitted ones show that the experience gained whilst teaching or being taught in a sealed-pattern type has led to marked improvements. Personally I am of opinion that only necessaries should be required, and I rebel against luxuries; for a student trained by means of the latter will, as a rule, in after life fail to meet with anything beyond the mere essentials for carrying on his scientific work.

The sealed pattern is practically in abeyance, though it can be trotted out as a bogey, and any properly equipped laboratory is recognised so long as it meets the absolute necessities of instruction.

The half-dozen chemical laboratories which existed in 1877 have now expanded to 349 physical and 774 chemical laboratories. These are spread over all parts of England. I leave out Scotland and Ireland, as the science teaching is no longer under the English Board of Education.

It is only fair to say that many of this large number of laboratories are at present in secondary schools, regarding which I shall have to speak more at length. But the fact remains that in twenty-seven years there has been such a growth of practical science teaching that some 1120

laboratories have come into being. My predecessor in the Chair likes to call laboratories "workshops." I have no objection, but the reverse; for the word "laboratory," like "research," sounds too magnificent for what is really meant, and all education should more or less be carried out in workshops.

The increase is as satisfactory as it is remarkable. It was only possible to increase the numbers in early days by gentle pressure and prophesying smooth things which, happily, did eventually come to pass. In later days the increase has been almost automatic. The Technical Instruction Act has called into being technical instruction committees who in many cases have taken up science instruction in their districts in earnest. They, too, have had public money to allocate, and not a little has gone in the encouragement of practical education. It may, however, be remarked that had it not been for the preliminary work that had been done by the Science and Art Department it is more than probable that the Technical Instruction Act of 1887 would never have seen the light.

A reference must now be made to the removal of what anyone will see was a great bar to the spread of sound instruction in every class of school where science was taught. So long as the student's success in examination was the test which regulated the amount of the grant paid by the State, so long was it impossible to insist on all-round practical instruction. It was impracticable to hold practical examinations for tens of thousands of students in some twenty different subjects of science. The practical examination in chemistry told its tale of difficulties. It was only when the Duke of Devonshire and Sir John Gorst in 1898 substituted for the old scheme of payments payment for attendance, and in a large measure substituted inspection for examination, that the Department could still further press for practical instruction. For all elementary instruction the test of outside examination does more harm than good, and any examination in the work done by elementary students should be carried out by the teacher, and should be made on the absolute course that has been given. It seems to be useless or worse that an examination should cover more than this. Instruction in a set syllabus which for an outside examination has to be covered spoils the teaching and takes away the liberty of method which a good teacher should enjoy. The literary work involved of answering questions, for an outside examiner, is also against the elementary student's success, and cannot be equal to that which may properly be expected from him a couple of years later.

Advanced instruction appears to be on a different footing. The student in advanced science must have gradually obtained a knowledge of the elementary portions of the subject, and it is not too much to ask him beyond the inspection of his work to express himself in decent English and to submit to examination from the outside; but even here the payment for such instruction should be by an attendance grant tempered in some degree by the results of examination, since examiners are not always to be trusted.

The attendance grant was not viewed by some with great favour at first, and protests were received against its adoption, a favourite complaint being that it was sure to entail a loss of grant. One became suspicious that some of those who protested were aware that the last bulwark which defended the earning of grants by cram was being removed, and that inspection might prove more irksome than examination. This is past history now, and the new system works as smoothly as the old and with not more complaints than are to be always expected.

As I have said, grants were for very many years supposed to be confined to aiding the instruction of the industrial classes, but this limitation was more nominal than real. It might probably be imagined that it was no very difficult task to distinguish an artisan and his children from students who belonged to the middle classes. This was not the case, however. Children belonging to the industrial class were, on joining a science class, obliged to state the occupation of the father, and it was no uncommon thing for fathers to be given brevet-rank by their children. Thus, a bricklayer's son would describe his father as a "builder," which, if true, ought to have brought him into the ranks of the middle class. These unauthorised promotions were one of the difficulties the inspector had to face when judging as to the status of the parents. This difficulty was largely met by a rule that all those who attended evening classes were supposed to be of the industrial class; but as day classes increased the numbers of those who by no possibility could be of the artisan class also increased, and it became a very invidious duty of the inspector to put M.C. (Middle Class) against the names of many. It was determined by superior authority that only those students or their parents who could claim exemption from income-tax should be reckoned as coming within the category of industrial students. In early days the qualification for abatement on income-tax was a much lower figure than it is to-day, and almost each succeeding Chancellor of the Exchequer has raised the figure of the income on which the abatement could be claimed. To-day it is, I believe, 700*l.* a year, bringing the official definition as to membership of the industrial classes to an absurdity. It became evident to the official mind, which some people are good enough to say works but slowly, that the definition must be amended or the limitation abolished. The progress of events happily made the abolition the better plan, and was the means of allowing inroads of science instruction to be made into secondary day schools.

The history of these inroads I shall now give. Instruction given in so-called organised science schools was originally aided by the Department by means of a small Capitation Grant. These schools were supposed to give an organised course of science instruction, and the successes at examination determined the payment. They were not satisfactory as at first constituted, and they so dwindled away in numbers that in 1890 only some one or two were left. A small increase in Capitation Grant in 1892 revived some of them, and a fair number existed in the following year. There was no doubt, however, that the conditions under which they existed were most unfavourable for a sound education, which ought not only to include science but also literary instruction. The latter was, in many schools, wholly neglected, owing to the fact that the grants earned depended on the results of examination, and so all the school time was devoted to grant earning.

Mr. Acland, at this time Minister for Education, was made aware of this neglect to give a good general education, and as I was at that time responsible for science instruction I was directed to draw up a scheme for reorganising these schools and forcing a general as well as scientific education to be carried out. Baldly the scheme abolished almost entirely[1] payments on results of examination, and the rate of grant depended on inspection and attendance. Further, a certain minimum number of hours had to be given to literary subjects, and another minimum to science instruction, a great deal of it being practical and having to be carried out in the "workshop." The payments for science instruction were to be withheld unless the inspector was satisfied that the literary part of the education was given satisfactorily.

The scheme was accepted and promulgated whilst the Royal Commission on Secondary Education was sitting, and, if I may be allowed to say so, Mr. Acland's tenure of office would be long remembered for this innovation alone, since in it he took a wide departure from the traditional methods of the Department and created a class of secondary school which differed totally from those then existing. Needless to say the scheme was not received with favour on all sides, more especially by those who thought that serious damage would be done to secondary schools by the competition from this new development of secondary education. I am not ashamed to say that the disfavour shown on some sides made me rejoice, as it indicated that a move had been made in the right direction. At first it was principally the higher-grade Board Schools that came under the scheme, and in the first year there were twenty-four of them at work. This type of school gradually increased until about seventy of them, and chiefly of a most efficient character, were recognised in 1900. Their further increase was only arrested by the Cockerton judgment, now so well known that I need only name it. But here we come to a most interesting development. State aid, as already said, was at first limited to the instruction of the industrial classes, but no limitation as to the status of the pupil was made in this new scheme for the schools of science, and logically this freedom was extended in 1897 to all instruction aided by the Department—the date when all limitation

[1] Within the next four years they will entirely cease.

as to the status of the pupil was abolished, the only limitation being the status of the school itself. Thus, if a flourishing public school, charging high fees for tuition, were to apply to participate in the grant voted by Parliament, it may be presumed, it would have to be refused. The abolition of the restriction as to the status of the pupils left it open to poorly endowed secondary grammar schools to come under the new scheme. To a good many the additional income to be derived from the grant meant continuing their existence as efficient, and for this reason, and often, I fear, for this reason alone, some claimed recognition as eligible.

Such is an outline history of the invasion of science instruction into certain secondary schools—an invasion which ought to be of great national service. In my view no general education is complete without a knowledge of those simple truths of science which speak to everyone, but usually pass unheeded day by day. The expansion of the reasoning and observational powers of every child is as material to sound education as is the exercise of the memory or the acquisition of some smattering of a language. I am not going into the question of curricula in schools, as I hope, regarding them, we shall have a full discussion. But of this I am sure, that no curriculum will be adequate which does not include practical instruction in the elementary truths of science. The President of the Royal Society, in his last Annual Address, alluded to the mediæval education that was being given in a vast number of secondary schools. Those who planned the system of education of those times deserve infinite credit for including all that it was possible to include. Had there been a development of science in those days, one must believe that with the far-seeing wisdom they then displayed they would have included that which it is the desire of all modern educationists to include. Observational and experimental science would have assuredly found a place in the system.

One, however, cannot help being struck by the broadening of views in regard to modern education that has taken place in the minds of many who were certainly not friendly to its development. Perhaps in the Bishop of Hereford, when headmaster of Clifton, we have the most remarkable early example of breadth of view, which he carried out in a practical manner, surrounding himself with many of the ablest teachers of science of the day. There are other headmasters who, though trained on the classical side, have had the prescience to follow in his footsteps, and of free will; but others there are who have neither the desire nor the intention, if not compelled to do so, to move in the direction which modern necessities indicate is essential for national progress. I am inclined to think that the movement in favour of modernising education has been very largely quickened by the establishment of schools of science in connection with endowed schools and the desire for their foundation by the Technical Instruction Committees, who had the whisky money at their disposal, and who often more than supplemented the parliamentary grants which these schools were able to earn. It was the circumstance that the new scheme was issued when many endowed schools were in low water that made it as successful as it has been.

The number of schools of science increased so rapidly that it appeared there might be a danger of too many of this type being started on sufficient educational grounds. Science instruction was carried in them to such an advanced point and so many hours of the week were spent on it that they became in some degree specialised schools. At least eight hours a week had to be devoted to science, ten to literary instruction, and five to mathematics—any further time available could be spent on any section that was considered desirable. For some pupils the time devoted to science is barely enough, but for others who intend to follow careers in which the literary section should predominate it appeared that some curtailment of hours in the science section might be usefully allowed, and it became a question how far such instruction might be shortened without impairing its soundness. After much anxious thought it was considered that four hours per week, besides mathematics, was the very least time that ought to be devoted to such instruction, and that the latter part of it should be practical work. A scheme embodying this modification was approved by the Lord President and the Vice-President whilst I was Principal Assistant Secretary for Secondary Education, and smaller grants than those for schools of science were authorised in 1901 for those schools which were prepared to adopt it. By the scheme instruction has to be given only in such subjects and to such an extent as is really necessary to form part of that general education of ordinary students who might not have to follow in industrial pursuits. This modified and shortened course has met with unqualified success. Some 127 schools came under the scheme the first year, and I gather that there will be a considerable increase in numbers in the future. The establishment of schools of science and of these schools may be considered to be a great step taken in getting practical instruction in natural knowledge introduced into secondary schools. The leaven has been placed in some 300 of them, and we may expect that all schools which may be eligible for State aid will gradually adopt one scheme or the other. Though it is said that there is nothing in a name, I am a little doubtful as to whether the earmarking of science education as distinct from secondary education is not somewhat of a mistake at the present day. For my own part, I should like to think that the days have passed when such an earmarking was necessary or advisable. The science to be taught in secondary schools should be part and parcel of the secondary education, and it would be just as proper to talk of Latin and Greek instruction apart from secondary education as it is to talk of science instruction. One of the causes of the unpopularity of the Science and Art Department was its too distinctive name. At the same time it would be most unwise at the present time, when the new Education Committees are learning their work and looking to the central authority for a lead, for the State to alter the conditions on which it makes its grants to these schools. It will require at least a generation to pass before modernised education will be free from assault. If science instruction is not safeguarded for some time to come it runs a good chance of disappearing or being neglected in a good many schools. As to the schools which have no financial difficulties, it is hard to say what lines they may follow. Tradition may be too strong in them to allow any material change in their courses of study. If it be true that the modern side of many a public school is made a refuge for the "incapables," and is considered inferior to the classical side, as some say is the case, such a side is practically useless in representing modern education in its proper light. Again, one at least of the ancient universities has not shown much sympathy with modern ideas, and so long as she is content to receive her students ignorant of all else but what has been called mediæval lore, so long will the schools which feed her have no great inclination to change their educational schemes.

If we would only make the universities set the fashion the public schools would be bound to follow. The universities say that it is for the public schools to say what they want, and *vice versâ*, and so neither one nor the other change. It appears to me that we must look to the modern universities to lead the movement in favour of that kind of education which is best fitted for the after life of the large majority of the people of this country. If for no other reason, we must for this one hail the creation of two more universities where the localities will be able to impress on the authorities their needs. The large majority of those whose views I share in this matter are not opposed to or distrust the good effects of those parts of education which date from ancient times. The great men who have come under their sway are living proofs that they can be effective now as they have been in times past, but we look to the production of greater men by the removal of the limitations which tradition sets. I myself gratefully acknowledge what the public school at which I had my early education did for me, but I think my gratitude would be more intense had I been given some small elementary instruction in that natural knowledge which has had to be picked up here and there in after life.

There is one type of college which I have not alluded to before, and that is the technical institutes. These have been fostered by the localities in which they are situated, and been largely supported by the whisky money, supplemented by Government aid. I am glad to see that in the last regulations of the Board of Education these colleges will receive grants for higher scientific instruction, and I have no doubt that in the near future such institutions and schools of science will receive a block grant, which will

give them even still greater freedom than they now enjoy. These are colleges to which students from secondary schools will gradually find their way, where they wish for higher education of a type different from that to be gained at a university.

I have endeavoured to give a brief historical sketch of what the State has done in helping forward instruction in natural knowledge amongst the industrial classes, adults and children, and how gradually its financial aid has been extended to secondary schools. I have also endeavoured to indicate the steps by which practical instruction has been fostered by it. I have done this because I am confident that ninety-nine educationists out of every hundred have but little idea what the State has been doing for the last fifty years. Some connected with secondary schools—I have personal knowledge—were until lately ignorant that the State had offered advantages to them of a financial nature. I may say that the work of the late Science and Art Department was largely a missionary work. It was abused, sometimes rightly but more often wrongly, for this very work, and it had more abusers at one time probably than any other Government Department. Even friends to the movement of modernising education found fault with it as antiquated and slow, but I can assure you that no greater mistake can be made in pressing forward any movement by any hurried change of front or by endeavouring to push forward matters too rapidly. In the first place, the Treasury naturally views untried changes with suspicion, and this fact has to be dealt with more particularly when there is no great expression of public opinion to reckon with. At the same time it cannot be stated too strongly that the Treasury has in recent years dealt in a friendly and enlightened spirit with all matters which could affect the spread of science. Again, there is a hostility to great and rapid changes in the minds of those whom such changes affect.

The policy must always be to progress as much as is possible without rousing too great an opposition from any quarter, and I think it will be seen that the progress made during the last twenty-five years has, by the various annual increments, been perhaps more than could have been hoped for, and gives a promise for even more rapid advances in the future.

As an appendix to this Address I have given a brief epitome of the increases in students, in schools, in laboratories, and in grants which have taken place since 1861. If to the last be added the amount spent out of the whisky money an additional half million may be reckoned.

It will be seen that the progress made has been gradual, but satisfactory, and that, if we showed some of the results graphically, weighted according to the circumstances of their date, and dared make an extrapolation curve of future results, we should have a complete justification for prophesying hopefully.

The question of the supply of science teachers has already been referred to. My remarks I should like to supplement by saying that in the greater number of schools teachers are to be found who have been trained at the Royal College of Science, and mostly at public expense—some through scholarships gained by competition and some through training selected teachers. The success of the movement for the introduction of science instruction in schools depended on the proper supply of teachers, and even now the demand for men possessing the highest teaching qualifications in science is greater than the supply. It may be said, I think, that our science teachers from the college have one special qualification, and that is, that besides the knowledge of science, practical and theoretical, that they have acquired they have lived in an atmosphere of what is called research, and which might be called original investigation. Professors, assistants, and students alike are impregnated with it, and when the teacher so trained takes up his duties in his school he still retains the "reek" of it. True instruction in science should, as I have before said, be practical, and practical instruction should certainly include original inquiry into matters old or new. The teacher who retains the "reek" is the teacher who will prove most successful. It will thus be seen that the State had the task before it, not only of introducing instruction in science, but of training teachers to give such instruction. This problem is the same as now exists in Ireland, and the experience gained in England cannot but be of the greatest use to those at the head of Irish technical education.

Before concluding there is one subject that I must lightly touch upon, and that is the supply of teachers other than science teachers. The Education Act of 1870 gave the power to elementary schools to train pupil teachers, who in the process of time would become teachers, either by entering into a training college by means of a King's Scholarship or, less satisfactorily, by examination. In large towns the need of a proper training for pupil teachers has been felt, and gradually pupil teacher centres were established, principally by School Boards, where the training could be carried out more or less completely; but in the rural districts and smaller towns the pupil teacher has had to be more or less self-taught, and except in rare cases "self-taught" means badly taught. The Training College authorities make no secret of the fact that one of the two years during which the training of the teacher is carried out has to be devoted more or less to instructing the pupils in subjects they ought to have been taught before they entered the college. Thus all the essential and special instruction which is given has to be practically shortened, and the teacher leaves the college with less training than he should have.

The new Education Act has put it in the power of the educational authorities to rectify the defects in the training of pupil teachers. It is much to be hoped that Councils will separately or in combination either form special centres for the training of all pupil teachers or else give scholarships (perhaps aided by the State) to them, to be held at some secondary school receiving the grant for science and recognised by the Board of Education as efficient. The latter plan is one which commends itself, as it ensures that the student shall associate with others who are not preparing for the same calling in life, and will prevent that narrowness of mind which is inevitable where years are spent in the one atmosphere of pedagogy. The non-residential training college, where the training of the teacher is carried on at some university college, is an attempt to give breadth of view to him, but if attempted in the earliest years of a teacher's career, it will be even more successful. All teaching requires to be improved, and the first step to take in this direction is to educate the pupil teacher from his earliest day's appointment, for his influence in after years will not only be felt in that elementary, but will also penetrate into secondary education. In regard to the additions which are required in elementary education, and which require the proper training of the pupil teacher, I must refer you to a report which will be presented to the Section. The task of training pupil teachers is one which requires the earnest and undivided thought of the new Education Committees.

In the earnest Address given by my predecessor in this Chair he brought forward the shortcomings of secondary education and of the requirements for a military career in a trenchant manner and with an ability which I cannot emulate. With much of what he said I agree heartily, but I cannot forget that, after all, the details of education are to some extent matters of opinion, though the main features are not. We must be content to see advances made in the directions on which the majority of men and women educational experts are agreed. Great strides have already been made in educating the public both in methods and subjects, but a good deal more remains to be done.

It may be expected, for instance, that the registration of teachers will lead to increased efficiency in secondary schools, and that the would-be teacher, fresh from college, will not get his training by practising on the unfortunate children he may be told off to teach. It may also be expected that such increased efficiency will have to be vouched for by the thorough inspection which is now made under the Board of Education Act, by the Board, by a university, or by some such recognised body. It again may be expected that parents will gradually waken up to the meaning of the teacher's register and the value of inspection, and that those schools will flourish best which can show that they too appreciate the advantages of each.

I have to crave pardon for having failed to give an Address which is in any way sensational. I have thought it better to review what has been done in the past within my own knowledge, and with this in my mind I cannot

but prophesy that the future is more than hopeful, now that the public is beginning to be educated in education. It will demand, and its wants will be supplied.

APPENDIX.

Number of Schools of Science and their Grants.

Year	Higher Grade Schools	Endowed Secondary Schools	Technical Institutes	Total Schools	Total Grants
					£
1895	53	30	29	112	39,163
1898	69	50	49	168	98,849
1901	63	106	43	212	118,833
1903	50	119	57	226	Not yet known[1]

Number of Schools teaching Shortened Course of Science.

Year	No.
1902	127
1903	184

Number of Laboratories recognised.

Year	Chemistry	Metallurgy	Physics	Biology	Mechanics
1880	133	—	—	—	—
1900	669	37	219	17	4
1901	722	37	291	26	10
1902	758	39	320	34	14

Grants paid for Science Instruction.

Year	Amount	Year	Amount
	£		£
1860	709	1890	103,453
1870	20,118	1895	142,543
1875	42,474	1901	212,982
1880	40,229	1902	240,822
1885	63,364		

[1] In 1902 124,300*l.* was paid.

THE GERMAN ASSOCIATION AT CASSEL.

THE seventy-fifth meeting of the German Association for the Advancement of Science and Medicine took place in brilliant weather in the picturesque town of Cassel. By Saturday evening, September 19, members and associates began to arrive, and on Sunday a large number of gaily coloured "rosettes" were visible in the streets. Advantage was taken of this gathering of men of science to present to Prof. Graebe, of Geneva, an address on the completion of the twenty-fifth year of occupancy of his chair of chemistry, and M. Moissan, of Paris, on behalf of the Chemical Society, conveyed to him the Lavoisier medal of the Institute of France. Prof. Graebe, who, in conjunction with Prof. Liebermann, of Berlin, achieved the first important chemical synthesis—that of artificial alizarine—was an old assistant of Prof. v. Baeyer, of Munich, who then occupied the chair of chemistry in the Gewerbe Akademie in Berlin. Prof. v. Baeyer, in his opening address, directed special attention to the cooperation of men of science with technologists, which was the fruit of this important synthesis—a cooperation which has had enormous influence on the development both of German science and industry. The rector of the University of Geneva followed, and he mentioned that, during the twenty-five years of Prof. Graebe's tenure of the chair, he had published 196 memoirs on chemical subjects, while more than 400 papers were published by workers in his laboratory. Prof. Moissan, who, as delegate of the Académie des Sciences, handed to Prof. Graebe the Lavoisier medal, referred in an eloquent speech to the great influence which Graebe's work has had in developing synthetical organic chemistry, and after the presentation of addresses from the Royal Academy of Sciences of Bavaria, from the German Chemical Society, from the Societies of Geneva and Frankfort, and from the University of Lausanne, Prof. Graebe received from the chairman a gold plaque, engraved with his portrait, and from M. Amé Pictet, on behalf of his old students, a bound copy of his own papers. Dr. Brunck, on behalf of the "Badische" Chemical Company, of which he is managing director, added a tribute to Graebe from the point of view of technology, and in an eloquent reply Prof. Graebe expressed his gratitude and thanks. About sixty of the audience remained to a dinner given in honour of Prof. Graebe, at which numerous toasts were drunk, and the proceedings were kept up until a late hour.

The members and associates met for the first time on Sunday evening, September 20, in the grounds of the Hessian Brewery, where a large hall had been adapted for the purpose of the general meetings, and on Monday morning, after words of welcome from Prof. Hornstein, of Cassel, the local secretary, from President von Trott zu Solz, from the mayor and others, the president of the Association, Prof. van 't Hoff, returned thanks in the name of the Association. An address was then delivered by Prof. Ladenburg on the influence of science on our views of life. The address treated of the gradual development of scientific knowledge and its opposition by the church; the necessity of education in the phenomena and laws of nature, and the insignificant position of man among natural phenomena; the doctrine of the immortality of the soul and the dicta of science on the subject. He contended that Christianity alone had been unable to induce mankind to accept the doctrine of liberty, equality, and fraternity, and that this doctrine, indispensable for our future progress, must be the future object of scientific endeavour. The general opinion of the audience appeared to be that Prof. Ladenburg's address was unnecessary, and that he had assumed for science an infallibility similar to that claimed by the Apostolic See. The second address, by Prof. Ziehen, of Utrecht, treated of impressions and sensations, and their connection with the surface of the brain. Sensations may be termed positive or negative, according as they produce pleasant or unpleasant emotions, and their intensity depends less on the degree of excitability of the regions of the brain affected than on the capacity for "discharge" or communication with other regions. "Negative" sensations are more numerous than positive; the lecturer attempted to prove this by the fact that, in German, words denoting unpleasant are more numerous than those which denote pleasant sensations. But up to now it had been impossible to bridge the gap between the mechanism of the brain and the sensations and perceptions.

In the afternoon the sections met, and in the evening the opera of "Tannhäuser" was well performed in the theatre. September 21 was devoted to sectional meetings, and in the evening the members and associates dined together in the "Festhalle," and many toasts were proposed. On the morning of the next day addresses were delivered by Prof. Penck, of Vienna, on geological time; by Prof. Schwalbe, of Strassburg, on the early history of man; and by Dr. Alsberg, of Cassel, on inherited degeneration as a consequence of social influences. On the morning of September 24 the medical side of the congress was represented by Dr. Allan Macfadyen, who gave an address on intercellular toxines; by Dr. Paul Jensen, on the physiological action of light; and by Dr. Rieder, on the curative results obtained by treatment with light.

Later in the morning, in order to open a discussion on the place of mechanics in our views of nature, papers were read by Dr. Schwarzschild, of Göttingen, on astronomical mechanics, by Prof. Sommerfeld on technical mechanics, and by Prof. Otto Fischer on physiological mechanics. Dr. Schwarzschild began by stating that Newton's law of gravitational attraction still remains the leading factor in astronomy, and every observation only serves as a confirmation of its correctness. It has been proved to be correct to two parts in one hundred millions. The chief aim of astronomical mechanics is to represent exactly the actual path of the planets. But the classical "Mechanics of the Heavens" fails, if it is applied to very long periods of time. The formulæ which are applied would, if extended, point to a destruction of the planetary system. There are, however, two reasons for believing that such a conclusion would be incorrect. The problem of "secular disturbances" was solved by Lagrange, and that of "commensurabilities"

has made great progress during the last thirty years. Under the last head may be grouped periodic and asymptotic paths, the problem of the gaps in the asteroids and the ring of Saturn, and the theory of the libration of the moons of Jupiter and Saturn. When these are carefully considered, they appear to point to the stability of the planetary system for all time. This conclusion is, indeed, rendered less general by Poincaré's proof of the divergence of series in the theory of disturbances, but it can nevertheless be shown that, during a long period of time, for which it is possible to give a lower limit, changes in the planetary system are unimportant. The problems which still face the astronomer who undertakes similar investigations were exemplified by Lexell's comet and Darwin's periodic paths.

Prof. Sommerfeld, in indicating the direction in which mechanics comes into technical use, spoke of the confirmation of experimental principles and the greater use of theory. He gave an account of the teaching of mechanics in the universities and Polytechnika of Germany, entering somewhat into detail as regards the order of presentment of various conceptions. Dr. Otto Fischer discussed the necessity of determining the dimensions, the mass, the centre of gravity, and the moment of inertia of various portions of the living body, and the effects of external and internal forces in altering these properties.

On the morning of September 25 Sir William Ramsay lectured on the periodic system of the elements, Prof. Griesbach on school hygiene, and Prof. von Behring on the fight against tuberculosis. Ramsay spoke of the various attempts which have been made to ascertain whether mass and inertia, on the one hand, are invariable, or, on the other, whether the atomic weights show signs of variation. On the whole, the evidence is negative. He then described the spontaneous change of the emanation from radium bromide into helium, and concluded with some speculations as to the possible formation and decomposition of what are at present regarded as elementary bodies. The subject of school hygiene, though a very important one, has little scientific interest, but the lecture of von Behring was listened to with the greatest attention. Prof. von Behring has a large estate at Marburg where experiments on tuberculosis are carried out on animals. For example, he has rendered it very probable that vaccination of cows with the tuberculosis antitoxin renders their milk immune, and that the milk, in its turn, may render human beings immune. He believes to have shown that infants acquire tuberculosis through milk, and that even before birth the skin of infants is penetrable by the tubercular bacillus. If such infants are nourished on the milk of cows which have been injected with tubercular bacillus, the milk contains an antitoxin, and the tendency towards tuberculosis is obviated. He advocated the view that adults seldom acquire tuberculous diseases unless they are early predisposed to receive them by infection as infants. But this tendency can be combated by feeding infants with milk from cows which, through vaccination with tubercular matter, have developed the suitable antitoxin.

Prof. van 't Hoff, the president of the Association, then concluded by giving a short account of the most important papers which had been communicated to the sections, after which he thanked the town of Cassel, in the name of the Society, for its hospitable reception.

The German "Naturforscherversammlung," unlike the British Association, includes many sections which treat of medical subjects. Only those lectures which are of general interest are delivered before the Association as a whole. The proceedings of the medical sections will doubtless find their way into the medical journals, and only the proceedings of scientific interest will be treated of here. Through the courtesy of the president and of Prof. Rassow, of Leipzig, abstracts of the more noteworthy of the papers in each section were furnished to the writer.

Of the mathematical section, it was merely stated that in all five meetings were held, in which twenty-eight papers were read, three being of some length. It would appear that mathematicians are too modest to thrust their views on the scientific brethren, or perhaps they doubt if they would be understood.

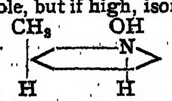
The most noteworthy papers in the physical section were, first, a confirmation by Prof. Rubens of Maxwell's theory by experiments on the optics of metals—their refractivity, and behaviour to electric currents; and, second, a paper by Prof. Nernst, in which he described and showed his iridium apparatus, by means of which a temperature of 2000° C. has been attained, and determinations of vapour density carried out. Nernst's "furnace" consists of an iridium tube about 10 inches long and 1½ inches diameter. By means of a powerful current which passes through the walls of the tube the temperature can be raised to any desired degree, short of the melting point of iridium. A small "bulb" of iridium, similar to that used for Victor Meyer's density apparatus, hangs inside the tube, and attains the temperature of the iridium tube. Nernst's balance, by means of which a couple of milligrams of substance can be correctly weighed to within a half per cent., consists of a glass fibre suspended by a quartz fibre at right angles to it; from one end hangs a small iridium capsule counterpoised by a small weight; the other end of the glass fibre projects over a mirror-scale; the balance acts partly by torsion of the quartz fibre, partly like a steelyard. The density of vapours of "non-volatile" substances is determined exactly as with a Victor Meyer apparatus, and while that of sulphur was found to correspond to S_1, that of phosphorus gave negative results in an atmosphere of nitrogen, due, no doubt, to the formation of a compound of phosphorus with nitrogen, stable only at a high temperature. Nernst also described his method of measuring high temperatures by noting the intensity of the radiation from the interior of the tube.

In the section of applied mathematics, Dr. Otto Thilo spoke of the necessity of a knowledge of mechanics for the investigator. By help of preparations and models he demonstrated the relation of sinews to bones, especially those which confine the motion to one plane, the mechanism for getting over the "dead-point," and those for restraint, so that muscular power is saved, for example, when a man is standing erect. He further went on to demonstrate the mechanism by which the pressure of air in the swimming-bladder of fishes is communicated to the brain. His contention was that even biologists must be instructed in mechanics if they wish to study the movements of living organisms.

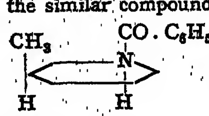
In the chemical section, Prof. Biltz spoke about the precipitation of colloids by salts. He advanced the theory that a colloidal solution consists of a colloid suspended in an electrolyte; when a precipitant is added a new form of combination occurs, for instance:—

Electrolyte – colloid + colloid-precipitant =
colloid – colloid-precipitant + electrolyte.

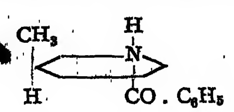
The precipitation of the iodine-starch substance by means of alumina was illustrated, and also of the meta-phosphoric acid-albumen couple. Prof. Ostwald suggested that the precipitation depends on the relative velocity of the two reactions, and that that reaction which takes place most rapidly gives rise to the formation of stable substances. Prof. Wedekind showed isomeric organic ammonium salts containing radicals of high molecular weight, and Prof. Ladenburg also read a paper on asymmetric nitrogen. Prof. Wallach mentioned a new instance of optical isomerism, in which, if the molecular weight of the substituting group is low, no isomerism is noticeable, but if high, isomerism exists. For example, the compound



gives us isomerides (the benzene nucleus is here seen in perspective), while the similar compounds



and



are isomeric.

Prof. Nernst read a paper on the theory of ozone formation. The potential difference between the system O_3, O_2|electrolyte|O_2 is 0·57 volt, and this corresponds with the heat of formation of ozone, for the couple has practically no temperature-coefficient. He calculated that if oxygen is heated to 6400° it should contain 10 per cent. of ozone, at 3230° 1 per cent., and at 2183° 0·1 per cent. In the sun the oxygen must be wholly in the state of ozone, owing to the high temperature and the enormous gravitational pressure. Prof. Abegg spoke of two cases of heterogeneous

equilibrium, and other papers treated of the ring formula for benzene, the use of the spectroscope in the determination of atomic weight (Runge), fluorescence and chemical constitution (Richard Meyer), &c.

In the section of applied chemistry, Prof. König spoke of the determination of fibre, cellulose, and lignin in plants, and of the decomposition of fodder by microbes, and Dr. Marquart, of Cassel, gave an account of Dr. Schenck's red-phosphorus. This variety is produced at a comparatively low temperature—about 180°—by heating a solution of yellow phosphorus in phosphorous bromide. It is precipitated out of the solution, and must be filtered off and washed with carbon disulphide to free it from yellow phosphorus. Its point of inflammation is that of ordinary red phosphorus, but it is in a state of such fine division as to be readily set on fire by rubbing if it be mixed with potassium chlorate; at the same time it gives off no fumes, and is therefore harmless to operatives who dip matches. The light red powder is soluble in caustic soda (for it probably contains an atom of replaceable hydrogen), and is reprecipitated by acids. Dr. Marquart spoke especially of the future of this substance in the manufacture of matches which ignite when rubbed on any surface, and which, at the same time, are without danger to workpeople.

In the section of geophysics, Dr. Mansing exhibited an apparatus for determining the ebb and flow, and also the direction and velocity, of currents, and likewise the pressure in deep water. The apparatus is electrically connected with a ship, and registers for thirty days. The advantage over apparatus which registers only in shallow water is obvious. Dr Nippolt read a paper on terrestrial magnetic variations, citing observations made partly by himself, but mainly by others. The curves which he obtained point to changes which occur simultaneously at different spots of the earth's surface; he interprets such changes as significative of changes in the internal nucleus of the earth, and of displacements of the relative positions of the earth's crust and the magma which he believes to exist in the interior. Prof. Krebs treated of subaqueous volcanic regions, and suggested that they may be points of connection between the sea-water and the earth's internal magma; he advocated that their position and nature deserve careful investigation on account of danger to passing ships. In another paper Dr. Krebs believed he had found an explanation of the inundations in Silesian Austria, in certain long areas of low barometric pressure from which regions of low pressure in Silesian Galicia can be deduced.

Dr. Wolkenhauer, in the geographical section, spoke of the oldest German maps, which he ascribed to the fifteenth and sixteenth centuries. The oldest maps are by Erhard Etzlaub; those of Cuza, which were formerly believed to have been published in 1491, appear to be as late as 1530. The attendance in this section was very small, owing to the meeting this year of geographers at Cologne.

In the botanical section the most important papers were by Prof. Kohl, who offered a proof that the central bodies of the Cyanophyceæ cells possess the properties of cell nuclei, and he expressed the belief that in the closely allied Schizomycetæ a similar proof could be found. Numerous experiments on Mycorrhizen, an account of which was given by Prof. Möller, proved that the existence of fungi on the roots of plants must be regarded as a case of parasitic existence, but not of symbiosis. Prof. Drude, who has made numerous experiments in the botanic garden at Dresden, contended that mutation cannot be sharply distinguished from variation, as De Vries believes, but that the difference is only one of degree. To prove his contention, he exhibited living specimens of *Oenothera Lamarckiana*, grown from seed which De Vries had given him.

In the zoological section only one meeting was held, at which lectures were delivered by Prof. Klunziger, Dr. Thilo, Dr. Eysell, and Dr. Basse. They were illustrated by demonstrations, but appear not to have contained any specially new matter.

The anthropological section excited a good deal of interest. Among the more important papers was one by Prof. Hagen, in which he demonstrated that the eight months' fœtus of the Malay and Melanesian races differed from the European fœtus by the shortness of the body compared with the limbs, and the greater diameter of the body in the region of the false ribs, &c. The Melanesian fœtus showed peculiarities from which he deduced the conclusion that the genus man became differentiated from other mammals at a very early period of history. On the other hand, Prof. Schwalbe, from investigation of the frontal sutures of apes and their comparison with those of man, contended that there is a close relationship to be observed between man and old-world apes. Prof. Gojanovic-Kramberger had examined human remains recently discovered in Croatia—the so-called *Homo crapinensis*—and concluded from his researches that in the Ice age two races were alive; the differences in the form of the jaws and teeth, the shape of the collar-bone, the upper arm and parts of the skull, were adduced as proof of his view. One of these races, he believed, showed analogy with the owner of the Neanderthal skull and the skeleton from the grotto of the Spy, so far as the morphological relationship could be traced.

One of the sections dealt with the teaching of mathematics and science in schools, and there Prof. Grimsell demonstrated the use of new apparatus designed to illustrate terrestrial magnetism and the mechanical equivalent of heat, and he showed a lantern which gave good images with an ordinary incandescent gas flame. Prof. Schotten gave a lecture which was largely attended, and at which much discussion took place on the suitability of zoology as a school subject. While most of the speakers agreed on its being easily taught and useful, doubt was expressed whether it was wise to add another subject to the already heavy load which a German boy is expected to carry. On the whole, the latter opinion was the more widely held.

After the meeting the members made excursions to objects of interest in the neighbourhood of Cassel. About seventy chemists and physicists visited Göttingen and inspected the laboratories of Profs. Nernst, Voigt, Rieke, and Wiechert; the last has been created only a few years, and is devoted to the investigation of the problems of "terrestrial physics." It is furnished with seismographs, instruments for investigating terrestrial magnetism, atmospheric electricity, &c., and good work is already being done in it. It is a handsome building at some distance from the town, and it may be held up as an example of the way in which the Germans leave no stone unturned to be first in the investigation of natural phenomena of all kinds. Some of the associates, chiefly medical, visited Marburg, in order to inspect Prof. von Behring's institute for the study of tuberculosis. The buildings and equipment must be characterised as magnificent. Here, again, is an instance of the cooperation of the scientific man and the manufacturer, for Dr. von Behring was for long scientific adviser to the firm of Höchst, which erected the laboratories, and undertook the manufacture of the antitoxin serum. Would that a similar spirit of cordial cooperation between English men of science and "practical" men could become more common!

W. R.

FORTHCOMING BOOKS OF SCIENCE.

MR. F. ALCAN (Paris) gives notice of:—"Essai sur le Langage intérieur et la Fonction endophasique à l'État normal et dans les États pathologiques," by Dr. G. Saint-Paul; "Travail et Plaisir," by Dr. Ch. Féré; "La Philosophie pratique de Kant," by V. Delbos; "Manuel d'Histologie pathologique," by Cornil, Ranvier, Brault et Letulle, Tome iii.; "Mécanisme et Éducation des Mouvements," by G. Demeny; "Les Défenses de la Vie," by Dr. J. Laumonier; "Histoire de l'Habillement et de la Parure, depuis les Temps préhistoriques jusqu'à nos Jours," by L Bourdeau; "Traité de Sylviculture—Exploitation et Aménagement des Bois," by Prof. P. Mouillefert; "L'Éducation," by C. A. Laesant."

Mr. George Allen promises:—"Ideals of Science and Faith," nine essays by Sir Oliver Lodge and various other writers, edited by Rev. J. E. Hand.

Mr. Edward Arnold's announcements include:—"The Chemical Synthesis of Vital Products and the Inter-relations between Organic Compounds," by Prof. R. Meldola, F.R.S.; "The Strength and Elasticity of Structural Members," by R. J. Woods; "The Evolution Theory," by Prof. A. Weismann, translated by Prof. J. A. Thomson, two volumes, illustrated; "Nature Study," by

Prof. L. C. Miall, F.R.S.; and a third series of "Memories of the Months," by Sir Herbert Maxwell, Bart.

Messrs. Baillière, Tindall and Cox announce:—"Health of Armies in the Field," by Major R. Caldwell; "The Nutrition of the Infant," by Dr. R. Vincent; and "Students' Aids to Chemistry," by T. A. Henry.

Messrs. A. and C. Black direct attention to:—"Trout Fishing: an Essay in the Study of Natural Phenomena," by W. Earl Hodgson, illustrated; "The Direction of Hair in Animals and Man," by Dr. W. Kidd, illustrated; and a new edition of "Text-book of Operative Surgery," by Dr. T. Kocher, translated by Dr. H. J. Stiles.

The list of the Cambridge University Press includes:—"Micro-cosmographie, or, a Piece of the World discovered; in Essays and Characters," by John Earle, printed from the sixth augmented edition of 1633; "Principia Ethica," by G. E. Moore; "The Algebra of Invariants," by J. H. Grace and A. Young; "The Collected Mathematical Papers of James Joseph Sylvester, F.R.S.," edited by Dr. H. F. Baker, F.R.S.; "Radio-activity," by Prof. E. Rutherford, F.R.S.; "The Fauna and Geography of the Maldive and Laccadive Archipelagoes. Being the Account of the Work carried on and of the Collections made by an Expedition during the years 1899 and 1900 under the leadership of J. S. Gardiner," vol. ii. part ii., illustrated; "Reports of the Anthropological Expedition to Torres Straits by the Members of the Expedition," edited by Dr. A. C. Haddon, F.R.S.; "Immunity in Infectious Diseases," by Prof. É. Metchnikoff, authorised English translation by F. G. Binnie, illustrated; "Rabies, its Place amongst Germ-diseases, and its Origin in the Animal Kingdom," by Dr. D. Sime; "The Natural History of some Common Animals," by O. H. Latter; "A Systematic Account of the Seed-Plants," by Dr. A. B. Rendle, vol. i.; "Fossil Plants, a Manual for Students of Botany and Geology," by A. C. Seward, F.R.S., vol. ii.; "The Morphology of Plants," by J. C. Willis; and new editions of Scott's "A Treatise on Determinants," by G. B. Mathews, F.R.S.; and "A Manual and Dictionary of the Flowering Plants and Ferns," by J. C. Willis.

The list of Messrs. Cassell and Co., Ltd., contains:—"Wild Nature's Ways," by R. Kearton, illustrated; "Nature's Riddles; or the Battle of the Beasts," by H. W. Shepheard-Walwyn, illustrated; and new editions of "The Automobile: its Construction and Management," edited by P. N. Hasluck; "A Manual of Operative Surgery," by Sir F. Treves; and "Elements of Surgical Diagnosis," by A. P. Gould.

Messrs. W. and R. Chambers, Ltd., will issue:—"Medicine, Surgery, and Hygiene in the Century," by Dr. E. H. Stafford; "Discoveries and Explorations of the Century," by Prof. C. G. D. Roberts; "Progress of Education in the Century," by J. L. Hughes and Dr. L. R. Klemm; "Progress of Science in the Century," by Prof. J. A. Thomson; and a new edition of "Practical Mathematics," revised under the supervision of Drs. C. G. Knott and J. S. Mackay.

Messrs. Chapman and Hall, Ltd., direct attention to:—"Man's Place in the Universe, a Study of the Results of Scientific Research in Relation to the Unity or Plurality of Worlds," by Dr. A. R. Wallace, F.R.S., with diagrams; "China, Past and Present," by E. H. Parker, with a map of China; "Life and Sport in China," by O. G. Ready, illustrated; "The Gun, Afield and Afloat," by H. Sharp, illustrated; "Æther and Gravitation," by W. G. Hooper, with diagrams; "A Short Memoir of Isaak Walton and his Friends," by S. Martin, illustrated; and "The Worship of the Dead, the Origin, Nature and History of Pagan Idolatry," by Colonel J. Garnier, R.E., illustrated.

The list of the University of Chicago Press (Chicago) contains:—"The Mental Traits of Sex," by H. B. Thompson; "The Psychology of Child Development," by I. King; "Animal Education," by J. B. Watson; "A History of Matrimonial Institutions," by G. E. Howard, three volumes; "Studies in Logical Theory," edited by J. Dewey; "Physical Chemistry in the Service of the Sciences," by Prof. J. H. van 't Hoff, translated by A. Smith; and "Studies in General Physiology," by J. Loeb, two parts.

Messrs. J. and A. Churchill announce new editions of Bloxam's "Chemistry," revised by Prof. J. M. Thomson and A. G. Bloxam; and "Elementary Practical Chemistry," by Profs. Clowes and Coleman, two parts.

The Clarendon Press will publish:—"The Theory of Continuous Groups," by J. E. Campbell; "Notes on Analytical Conics," by Dr. A. C. Jones; "The Logic of Arithmetic," by Mrs. M. Boole; "Index Kewensis Plantarum Phanerogamarum." Supplementum Secundum, confecerunt T. Durand et B. D. Jackson; Goebel's "Organography of Plants," authorised English edition, by Prof. I. Bayley Balfour, F.R.S., vol. ii.; Pfeffer's "Physiology of Plants," translated by Dr. A. J. Ewart, vol. ii.; and "Plant Geography upon a Physiological Basis," by the late Dr. A. F. W. Schimper, the authorised English edition by Prof. W. R. Fisher, revised by Prof. P. Groom, in four monthly parts, illustrated.

Messrs. Archibald Constable and Co., Ltd., give notice of:—"Motor Vehicles and Motors," by W. W. Beaumont, vol. ii., illustrated; "The Motor Pocket Book," by M. O'Gorman and Cozens-Hardy; "The Engineer in South Africa," by S. Ransome, illustrated; "Liquid Fuel and its Combustion," by W. H. Booth, illustrated; "Dust Destructors," by W. F. Goodrich, illustrated; "Construction in Reinforced Concrete," by C. F. Marsh, illustrated; "Air Engines and Machinery," by G. Halliday, illustrated; "The Lymphatics," by G. Delamere, P. Poirier, and B. Cunéo, illustrated; and "New Methods of Treatment," by Dr. Laumonner, edited by Dr. Sayers.

The *Electrician* Company, Ltd., announce:—"Handbook of the Electrical Laboratory and Testing Room," by Dr. J. A. Fleming, second volume, illustrated; and new editions of the "International Telegraph Convention and Telegraph and Telephone Service Regulations," and "Localisation of Faults in Electric Light Mains," by F. C. Raphael.

Messrs. R. Friedländer and Son (Berlin) give notice of:—"Käferfauna der Balkanhalbinsel," by V. Appelbeck, *Berichte* der Deutschen Chemischen Gesellschaft, reprint of vols. i.–vi., 1868–73; "Die Vögel der palaearktischen Region," by E. Hartert; and "Das Tierreich," Lief. 20.

Messrs. Funk and Wagnalls announce:—"A Guide to Electro-Diagnosis and Electro-Therapeutics," by Dr. T. Cohn.

Messrs. Gibbings and Co., Ltd., promise:—"Science in Arcady," by Grant Allen; "Man and Beast," by Rev. C. Wood; "Geological Stories," by J. E. Taylor; "British Fossils," by J. E. Taylor; "Playtime Naturalist," by J. E. Taylor; and "Sagacity and Morality of Plants," by J. E. Taylor.

The list of Messrs. Charles Griffin and Co., Ltd., includes:—"The Metallurgy of Steel," by F. W. Harbord, with a section on "The Mechanical Treatment of Steel," by J. W. Hall, illustrated; "Precious Stones: their Properties, Occurrences, and Uses," by Dr. M. Bauer, translated by L. J. Spencer, illustrated; "Cyaniding Gold and Silver Ores," by H. F. Julian and E. Smart, illustrated; "The Principles and Practice of Dock Engineering," by Brysson Cunningham, illustrated; "Electricity Control, a Treatise on Electricity Switchgear and Systems of Transmission," by L. Andrews, illustrated; "The Micrography of Steel, a Handbook of the Methods Employed in the Investigation of the Microstructure of Steel and its Constituents," by F. Osmond and J. E. Stead, F.R.S., with an appendix including Mr. Stead's latest researches, illustrated; "The Elements of Mining and Quarrying," by Prof. C. Le Neve Foster, F.R.S., illustrated; "Fire and Explosion Risks, a Handbook of the Detection, Investigation, and Prevention of Fires and Explosions," by Dr. von Schwartz, translated from the revised German edition by C. T. C. Salter; "Applied Anatomy: a Treatise for Students, House Surgeons, and for Operating Surgeons," by Dr. Edward H. Taylor, illustrated; "The Chemistry and Pathology of the Urine," by Dr. J. D. Mann, illustrated; "Methods and Calculations in Public Health and Vital Statistics," by Dr. H. W. G. Macleod, illustrated; "Milk: its Production and Uses, with Chapters on Dairy Farming, the Diseases of Cattle, and on the Hygiene and Control of Supplies," by Dr. E. F. Willoughby, illustrated; "A Text-book of Physics," by Profs. J. H. Poynting, F.R.S., and J. J. Thomson, F.R.S., vols. on heat, light, magnetism and electricity; and new editions of "The Cyanide Process of Gold Extraction, a Text-book for the

Use of Metallurgists and Students at Schools of Mines, &c.," by Prof. J. Park, illustrated; "A Manual of Marine Engineering: Comprising the Designing, Construction, and Working of Marine Machinery," by A. E. Seaton, illustrated; and "Central Electrical Stations: their Design, Organisation, and Management," by C. H. Wordingham, illustrated.

Messrs. Gurney and Jackson will issue vol. i., containing parts i. and ii., of an enlarged edition of Dr. G. Lunge's "Theoretical and Practical Treatise on the Manufacture of Sulphuric Acid and Alkali."

Mr. W. Heinemann's list includes:—"The Regions of the World," edited by H. J. Mackinder, vol. iv., India, by Colonel Sir T. Holdich, vol. v. North America, by I. C. Russell; "The Founder of Mormonism, a Psychological Study of Joseph Smith, jun.," by J. W. Riley; "The Nature of Man, Studies in Optimistic Philosophy," by Prof. E. Metchnikoff, authorised English translation, edited by Dr. P. C. Mitchell, illustrated; and in the Dainty Nature Series, "The Brook Book," by M. R. Miller, illustrated.

Mr. R. Brimley Johnson promises:—"Mrs. Piper and the Society for Psychical Research," by M. Sage, translated.

Mr. Henry Kimpton's list is as follows:—"Bacteriology, a Manual for Students and Practitioners," by Dr. F. C. Zapffe, illustrated; and new editions of "The Physiological Feeding of Infants," by Dr. E. Pritchard; "The Treatment of Disease by Electric Currents," by Dr. S. H. Monell, illustrated; "Elements of Correct Technique," by Dr. S. H. Monell; "Medical German, a Manual Designed to Aid Physicians in their Intercourse with German Patients and in Reading Medical Works and Publications in the German Language," by S. Deutsch.

Mr. John Lane gives notice of:—Handbooks of practical gardening, edited by H. Roberts, illustrated: "The Book of Herbs," "The Book of Shrubs," "The Book of the Daffodil," "The Book of the Lily," "The Book of Topiary," "The Book of Town and Window Gardening," "The Book of Rarer Vegetables," "The Book of the Iris," and "The Book of Garden Furniture."

Mr. F. Lehmann (Stuttgart) announces:—"Das Mineralreich," by Prof. R. Brauns.

Messrs. Crosby Lockwood and Sons direct attention to:—"Watch Repairing, Cleaning, and Adjusting," by F. J. Garrard, illustrated; "An Elementary Treatise on Hoisting Machinery, including the Elements of Crane Construction and Descriptions of the Various Types of Cranes in Use," by J. Horner; "Gas and Oil Engine Management, a Handbook for Users, being Notes on Selection, Construction, and Management," by M. P. Bale; "An Introduction to Pure and Applied Geometry," by E. Sprague, illustrated; and new editions of "Clocks, Watches, and Bells for Public Purposes," by E. Beckett, Lord Grimthorpe, illustrated; and "The Elements of Electrical Engineering, a First Year's Course for Students," by T. Sewell, illustrated.

The announcements of Messrs. Longmans and Co. include:—"A Social History of Ancient Ireland, Treating of the Government, Military System and Law, Religion, Learning and Art, Trades, Industries and Commerce, Manners, Customs and Domestic Life of the Ancient Irish People," by Dr. P. W. Joyce, 2 vols., illustrated; "The Great North-West and the Great Lake Region of North America," by P. Fountain; "First Lessons in Observational Geometry," by Mrs. W. N. Shaw; "Education as Adjustment, Educational Theory Viewed in the Light of Contemporary Thought," by Prof. M. V. O'Shea; "Queries in Ethnography," by Dr. A. G. Keller; and "Steam Boilers, their Theory and Design," by Prof. H. de B. Parsons, illustrated.

Messrs. Luzac and Co. will issue:—"The History of Philosophy in Islam," by T. J. de Boer, translated by E. R. Jones; and "The Indian Sect of the Jainas," by T. G. Bühler, translated by Dr. J. Burgess.

Messrs. James Maclehose and Sons (Glasgow) announce:—"The Principal Navigations, Voyages, Traffics, and Discoveries of the English Nation made by Sea or Overland to the Remote and Farthest Distant Quarters of the Earth at any Time within the Compass of these 1600 Years," by Richard Hakluyt, preacher and sometime student of Christ Church in Oxford, in 12 vols.; "Museums, their History and their Use, with a Bibliography and List of Museums in the United Kingdom," by Dr. D. Murray, 3 vols.

In the announcements of Messrs. Macmillan and Co., Ltd., we notice:—"The Life of Sir William Henry Flower, F.R.S.," by C. J. Cornish, with photogravure portraits; "The Native Tribes of the Northern Territory of Australia," by Prof. B. Spencer, F.R.S., and F. J. Gillen, illustrated; "Wild Tribes of the Malay Peninsula," by W. W. Skeat, illustrated; Cambridge Natural History, illustrated: vol. vii., "Balanoglossus, &c.," by Dr. S. F. Harmer, F.R.S., "Ascidians and Amphioxus," by Prof. W. A. Herdman, F.R.S., "Fishes," by Dr. W. Bridge and G. A. Boulenger, F.R.S.; vol. i., "Protozoa," by Prof. M. Hartog, "Sponges," by Prof. W. J. Sollas, F.R.S., "Jelly-fish, Sea-anemones, &c.," by Prof. S. J. Hickson, F.R.S., "Star-fish, Sea-Urchins, &c.," by Prof. E. W. MacBride; vol. iv., "Spiders, Mites, &c.," by C. Warburton, "Scorpions, Trilobites, &c.," by Dr. M. Laurie, "Pycnogonids," by Prof. D'Arcy W. Thompson, "Linguatulida and Tardigrada," by A. E. Shipley, "Crustacea," by Prof. W. F. R. Weldon, F.R.S.; "Education, and other Subjects," by the Right Hon. Lord Avebury, F.R.S.; and new editions of "A Handbook of Metallurgy," by Prof. C. Schnabel, translated and edited by Prof. H. Louis, 2 vols., illustrated; and "A Systematic Survey of the Organic Colouring Matters," by Drs. G. Schultz and P. Julius, translated and edited, with extensive additions, by A. G. Green.

Messrs. Methuen and Co.'s list contains:—"The Gods of Egypt," by Dr. A. E. W. Budge, 2 vols., illustrated; "The Elements of Metaphysics," by A. E. Taylor; "The Way to be Healthy and Wealthy and Wise; What to Wear and the Way to Wear it," by Mrs. C. Muller; and "Prehistoric Man in England," by Dr. B. C. A. Windle, F.R.S., illustrated.

Mr. G. A. Morton (Edinburgh) promises:—"The Life History of British Lizards," by Dr. G. Leighton, illustrated.

Mr. Murray promises:—"A Manual of Pathology," by Prof. S. Martin, illustrated; "Eleanor Anne Ormerod, LL.D., Economic Entomologist, Autobiography and Correspondence," edited by Prof. R. Wallace, illustrated; "Some Indian Friends and Acquaintances," by Lieut.-Colonel D. D. Cunningham, F.R.S. This volume deals with the habits of some of the commoner bird and animal inmates of the streets and gardens of Indian towns as observed during a residence of nearly thirty years' duration in Bengal; "The Bacteriology of Milk, with Special Chapters on the Spread of Disease by Milk and the Control of the Milk Supply," by Dr. G. Newman and H. Swithinbank, illustrated; "Artillery and Explosives, Essays and Lectures Written and Delivered at Various Times," by Sir A. Noble, K.C.B., F.R.S., illustrated; "Signs of Life, a Series of Lectures on Physiology," by Dr. A. D. Waller, F.R.S., illustrated; "Heredity," by Prof. J. A. Thomson, illustrated (the Progressive Science Series); "The Home Mechanic," by J. Wright, illustrated; "Growth and Spread of Culture," by Prof. E. B. Tylor, F.R.S., illustrated; "Animal Life," by Prof. W. B. Bottomley; "Plant Life," by Prof. W. B. Bottomley; "Algebra," part ii., by E. M. Langley and S. R. N. Bradly; "Telegraphs and Telephones," by Sir W. H. Preece, K.C.B., F.R.S.; "The Calculus for Artisans," by Prof. O. Henrici, F.R.S.; "The Elements of Moral Philosophy," by Prof. M. C. Sen; and a new edition of "Primitive Culture, Researches into the Development of Mythology, Philosophy, Religion, Language, Art and Custom," by Prof. E. B. Tylor, F.R.S.

Messrs. George Newnes, Ltd., will publish:—"Beautiful and Rare Trees and Plants," by the Earl Annesley, illustrated; and in the Library of Useful Stories: "The Story of the Atlantic Cable," by C. Bright, illustrated; and "The Story of the Extinct Civilisations of the West," by R. E. Anderson, illustrated.

In the list of Messrs. C. Arthur Pearson, Ltd., we observe:—"The Romance of Modern Engineering," by A. Williams, illustrated; and a new edition of "From Franklin to Nansen," by G. F. Scott, illustrated.

Messrs. G. P. Putnam's Sons announce:—"The Law of Mental Medicine," by T. J. Hudson; "Sociology: the

Science of Human Society," by Dr. J. H. W. Stuckenberg; "Psychology and Common Life, a Survey of the Present Results of Psychical Research, with Special Reference to their Bearings upon the Interests of Everyday Life," by F. S. Hoffman; "Christopher Columbus," by J. B. Thacher, 3 vols., illustrated; and a new edition of "Thinking, Feeling, Doing," by Dr. E. W. Scripture.

Mr. Grant Richards promises:—"The Law of Evolution: its True Philosophical Basis," by J. Scouller; and a new illustrated edition of "Pioneers of Evolution," by E. Clodd.

Messrs. Rivingtons' list contains:—"Arithmetical Types and Examples," by W. G. Borchardt; and Rivingtons' Junior Mathematics, by H. G. Willis, "Arithmetic," part ii.

In the list of Messrs. George Routledge and Sons, Ltd., are to be found:—"The Management of Infancy and Childhood in Health and Disease," by Dr. H. Barratt; "Tube, Train, Tram, and Car, a non-Technical Description of Electric Locomotion," by A. H. Beavan; "Nature Study Readers," edited by J. C. Medd; "Electric Locomotion," by Sir W. Preece, K.C.B., F.R.S.; and a new edition of Morris's "British Butterflies."

The Sanitary Publishing Co., Ltd., announce:—"The Zymotic Enquiry Book," by J. Storey; "The Full Solution of the Sewage Problem, being the Presidential Address to the Association of Managers of Sewage Disposal Works at Carshalton, March 28, 1903," by W. D. Scott Moncrieff; "The *Sanitary Record* Diary and Year-Book"; "The *Sanitary Record* and Journal of Sanitary and Municipal Engineering, &c.," by Dr. W. Robertson; and new editions of "Disinfection and the Preservation of Food, together with an Account of the Chemical Substances used as Antiseptics and Preservatives," by Dr. S. Rideal; and "The Purification of Sewage and Water," by W. J. Dibden.

The Walter Scott Publishing Company, Ltd., are adding to their "Contemporary Science Series":—"Morals: a Treatise on the Psycho-Sociological Bases of Ethics," which is a translation, by W. J. Greenstreet, of Duprat's "La Morale"; "Consumption, its Nature, Causes, Prevention, and Cure," by Dr. S. de Plauzoles; "Indigestion, its Prevention and Cure," by Dr. F. H. Alderson; and a new edition of "An Introduction to Comparative Psychology," by Prof. C. Lloyd Morgan, F.R.S.

Messrs. Smith, Elder and Co., give notice of:—"A Naturalist in the Guianas," by E. André, illustrated; "Doctors and their Work, or Medicine, Quackery, and Disease," by R. Brudenell Carter.

The announcements of Messrs. Swan Sonnenschein and Co., Ltd., include:—"A History of Contemporary Philosophy," by Prof. M. Heinze, translated by Prof. W. Hammond; "Physiological Psychology," by Prof. W. Wundt. A translation of the fifth and wholly rewritten (1902–3) German edition, by Prof. E. B. Titchener, in three volumes, vols. i. and ii., illustrated; "The Philosophy of Auguste Comte," by Prof. L. L. Bruhl, translated with notes and index by the Hon. Mrs. de Beaumont-Klein; "Some Popular Philosophy," by G. H. Long; "The Student's Text-book of Zoology," by A. Sedgwick, F.R.S., vol. ii., illustrated; "The Fourth Dimension," by C. H. Hinton, illustrated; "Fatigue," by Dr. Mosso, translated by W. B. Drummond, illustrated; "Cancer: Nature's Own and Only Remedy," by Dr. C. Carillo; "Specimens of Bushman Folklore," by Dr. W. H. J. Bleek and Miss L. C. Lloyd; and a new edition of "Introduction to the Study of Organic Chemistry," by J. Wade, illustrated.

The list of the University Tutorial Press, Ltd., comprises:—"Modern Navigation," by Rev. W. Hall; "The Shilling Arithmetic"; "The Key to the New Matriculation Algebra"; "The School Arithmetic," by W. P. Workman; "Advanced Botany," by J. M. Lowson; "Graphical Representation of Algebraic Functions," by C. H. French and G. Osborn; and new editions of "The Tutorial Dynamics" and "The Tutorial Statics," by Dr. W. Briggs and Prof. G. H. Bryan, F.R.S.; "Advanced Magnetism and Electricity," by Dr. R. W. Stewart; "First Stage Magnetism and Electricity," by Dr. R. H. Jude; "Advanced Mechanics," vol. i., Dynamics; vol. ii., Statics, by Dr. W. Briggs and Prof. G. H. Bryan, F.R.S.; and "A Higher Text-book of Magnetism and Electricity," by Dr. R. W. Stewart.

Mr. T. Fisher Unwin gives notice of:—"Big Game Shooting and Travel in South and East Africa," by F. R. H. Findlay, illustrated; "The Mystics, Ascetics and Saints of India," by J. C. Oman, illustrated; "Bird Life in Wild Wales," by J. A. W. Bond, illustrated.

Messrs. Whittaker and Co. will issue:—"Electric Traction, a Practical Handbook on the Application of Electricity as a Locomotive Power," by J. H. Rider; "Electric Lighting and Power Distribution," by W. P. Maycock, vol. ii.; "Friction and its Reduction," by G. U. Wheeler; and new editions of "The Dynamo," by C. C. Hawkins and F. Wallis; "Electricity in its Application to Telegraphy," by T. E. Herbert; and "The Alternating Current Circuit and Motor," by W. P. Maycock.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The election of a professor of physiology in succession to Sir Michael Foster will take place on November 6, and the election to the chair of mechanism and applied mechanics, vacant by the resignation of Prof. Ewing, on November 14. Candidates are requested to communicate with the Vice-Chancellor.

Mr. J. M. Dodds, Peterhouse, and Mr. E. W. Barnes, Trinity, have been appointed moderators, and Mr. A. Berry, King's, and Mr. A. S. Ramsey, Magdalene, examiners for the mathematical tripos, 1904.

Mr. J. E. Wright, senior wrangler 1900 and Smith's prizeman 1902, and Mr. H. A. Webb, third wrangler 1902, have been elected to fellowships at Trinity College.

The Duke of Norfolk has contributed 8000*l.* towards the endowment of a university in Sheffield, if the charter be granted. Sir F. Mappin, Sir H. Stephenson, and the Sheffield Corporation Tramways committee have also each given 5000*l.*

In some American colleges there is a system by means of which the work done throughout the various terms of the college course is taken into account in awarding a student a degree. The plan adopted is known as the credit system. Thus in the current "Year Book" of the Michigan College of Mines, there is published an outline list of courses of instruction arranged in order of sequence, and under each main subject is given the number of attendances which must be made at the classes in different branches of that subject in order to secure certain credits. To take two instances, under the heading mathematics we find "spherical trigonometry, six times a week, five weeks; to count as three-tenths of a credit." Or, under physics, "light, six hours a week, twelve weeks; to count as two-tenths of a credit," and so on. By some such plan in this country regularity of attendance by students at their classes would be quite assured.

Mr. S. D. Chalmers has been appointed head of the new department of technical optics at the Northampton Institute, Clerkenwell. Evening classes in technical optics were started at the Northampton Institute as part of the work of the Applied Physics Department in the session 1898–99. In the first session the students largely consisted of those who desired to take the examinations of the Spectacle Makers' Company, and the work was confined to lectures and laboratory work. In the following session an optical workshop was added, and an increasing number of students engaged, professionally or otherwise, in optical work have in recent years been enrolled as students. Owing to the assistance of the London Technical Education Board, it has now become possible to separate the department of technical optics from that of applied physics, and place it in charge of a responsible head who can devote his whole time to its organisation and development.

The following entrance scholarships in connection with medical schools have been awarded:—St. Mary's Hospital Medical School—natural science scholarship, 145*l.*, G. E. Oates, St. Paul's School; natural science scholarships, 78*l.* 15*s.*, (1) J. E. L. Johnston, Epsom College and St. Mary's Hospital, (2) W. E. Haigh, Bradford Technical College; natural science scholarship, 52*l.* 10*s.*, D. W. Daniels, Wyggeston Schools, Leicester; university scholar-

ships, 63*l.*, (1) W. A. E. Dobbin, University College, Cardiff, (2) E. Beaton, Portsmouth Grammar School and Caius College, Cambridge. London Hospital Medical College—first prize, entrance science scholarship, 120*l.*, W. H. Palmer; second prize, entrance science scholarship, 60*l.*, J. E. Scudamore; third prize, entrance science scholarship, 35*l.*, J. P. Johnson; anatomy and physiology prize, scholarship open to students of Oxford and Cambridge, scholarship, 60*l.*, H. S. Souttar, University of Oxford. King's College, London (Faculty of Medicine)—medical entrance, 50*l.*, W. T. Briscoe and W. D. Sturrock (equal); Sambrooke (science), 100*l.*, E. Gauntlett; Warneford (arts), 100*l.*, O. J. W. Adamson.

PROF. E. A. SCHAFER, F.R.S., delivered the introductory address to the medical students at the Yorkshire College, Leeds, at the opening of the winter session on October 1. The object of the address was to offer practical suggestions with regard to the manner in which a medical curriculum might be mapped out in existing circumstances. It was appalling to think, said Prof. Schafer, that many people who passed as highly educated had absolutely no knowledge of any of the sciences except, perhaps, mathematics. He went on to say that, as a subject of general education, scientific knowledge was an absolutely essential preliminary to the study of medicine, and that because such knowledge was not imparted in our schools it had become necessary to incorporate into the medical curriculum, and in so far to burden it with, courses of preliminary science.

THE distribution of medals, prizes, and diplomas to the students of the Royal College of Science, South Kensington, took place on October 8, when Prof. J. B. Farmer, F.R.S., delivered an address, in the course of which he said it was still unfortunately true that many people of influence, while freely admitting the claims of science as a factor of ever-growing importance in the world of production and industry, nevertheless, when they said they wanted more technical education in the country, did not really want either science or education at all. What they did desire was merely some ready means of instruction that should adapt the knowledge already in sight to industrial and technical purposes. He believed in securing a more widespread and intelligent interest in the meaning of science and the modes by which knowledge might be really advanced. Chief among these was assuredly research.

IN distributing the prizes to the successful students of the Halifax Municipal Technical School last week, Mr. Bryce, while commending the study of commerce as a matter of science and philosophy, urged the authorities at Halifax to fix their attention principally to applied science. "But," he added, "our experience, and that of Germany and the United States, has shown that applied science, to be valuable, must be in connection with theoretical science, and in this country there must be ampler provision for teaching the higher branches of theoretical science if we are to make progress with those branches of science concerned with the practical arts. There is no reason in the world why England should not have as great a career in commerce and manufactures in the future as in the past. A country which wishes to keep abreast of modern trade must keep abreast of modern science. We have been falling behind in the study of science and its application to our industries in this modern world of ours. Science is king, and the commercial and industrial future is with the nations able most completely to master and apply the forces of nature in the most economical way."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 5.—M. Albert Gaudry in the chair.—The influence of water on the structure of the aerial roots of orchids, by M. Gaston **Bonnier**. Contact with water produces an effect on the aerial roots of many orchids, either by preventing the sclerification or lignification of the tissues of the central cylinder, a result which seems natural when compared with the modifications of the roots of aquatic plants, or by provoking a reaction tissue in the pericycle, capable of protecting the rest of the cylinder against the action of water.—On a class of linear differential equations, by M. Alexander **Chessin**.—The conditions which determine the sign and the magnitude of electrification by contact, by M. Jean **Perrin**. The contact charge between a solid and a liquid can be readily studied by means of electrical osmosis, the charge being always greater when the body is a good ioniser, such as water.—The heats of combustion of organic compounds considered as additive properties; alcohols and phenols, ether-oxides, aldehydes and ketones, by M. P. **Lemoult**. By assigning definite values to certain atomic groupings it is possible to calculate the heats of combustion of organic compounds of the above-mentioned classes with considerable accuracy.—The action of phosphorous acid upon mannite; remarks on mannide, by M. P. **Carré**. The ether

$$P_2(OH)_4.O_2(CH_2)_2.(CH.OH)_4$$

is first formed, a phosphite of mannide being ultimately produced.—Derivatives and products of oxidation of nitropyromucic acid, by M. R. **Marquis**. This acid is totally destroyed by oxidation with permanganates, chromic acid or nitric acid, but with sodium peroxide gives nitrous and fumaric acids.—Researches on the formation of azo-compounds. The reduction of ortho-nitrobenzyl-methyl ether oxide, by M. P. **Freundler**.—On the affinities of the genus Oreosoma, by M. G. A. **Boulanger**.—The action of solutions of salts of the alkalis and alkaline earths on fish, by M. Michel **Siedlecki**.—On the genus Ascodesmis, by M. P. A. **Dangeard**.—Researches on the transpiration of green leaves, either the upper or lower face of the leaf being illuminated, by M. Ed. **Griffon**.—On the development of the embryo of the rush, by M. Marcellin **Laurent**.—On ægyrine granites and riebeckite in Madagascar and their contact phenomena, by M. **Lacroix**.—On the functions of the *Charriages* in the delphino-provençal Alps and of the fan-like structure of the Alps of the Briançonnais, by M. W. **Kilian**.

CONTENTS.

THURSDAY, OCTOBER 22, 1903.

ANCIENT CALENDARS.

Ancient Calendars and Constellations. By the Hon. Emmeline M. Plunket. Pp. xvi + 263. (London: Murray, 1903.) Price 9*s.* net.

THIS fascinating work consists of a series of reprints, arranged in logical order, of papers contributed at different times, chiefly to the *Proceedings* of the Society of Biblical Archæology. Altogether they give us an able summary of what is now known respecting the ancient calendars of the Babylonians, Egyptians, Indians, and Chinese, and a very interesting discussion of the vexed question of the origin of the ancient (especially the zodiacal) constellations, on which subject the author has succeeded in throwing fresh light, her conclusions being corroborated by approaching the question of precessional change from different points of view.

The first chapter is on the calendar of the Accadians, who possessed the country watered by the Euphrates and Tigris before the Semitic conquest. Now this calendar was sidereal, not tropical like ours; it was founded, that is to say, on the positions of the sun amongst the zodiacal constellations, not those with respect to the equinoxes. Although the importance to us in these climates of seasonal changes leads us to make our calendar conform in length to the tropical year, as it is called, yet reminiscences of the old usage remain. Thus in the "Nautical Almanac" the sun is said to enter Aries at the time of the vernal equinox, though he is really then situated in the constellation Pisces; and this having excited the surprise of some people who in these days dabble in astronomical questions without having studied them, the superintendent has, beginning with this year, tried to help them by inserting "sun enters *sign* Aries." But as it has generally been erroneously supposed that most of the ancient calendars began the year with the vernal equinox or thereabouts (in this way the old Roman usage made March the first month in the year, whence we still have September to December nominally the seventh to the tenth months), the conclusion was drawn that the zodiacal constellations were formed into a series to mark the different times of the year at an epoch when the sun was really entering Aries at the vernal equinox, which would be about three thousand years ago.

The Accadian calendar, however, it is now known, went back ages before that, and Miss Plunket puts forth the very probable theory that the true date of its commencement and of the twelve Mazzaroth (if we may use the Hebrew term for the zodiacal signs) was about B.C. 6000. That the initial sign was from the first the Ram (of the eminence of which we have so many indications in Egyptian antiquities) there seems no reason to doubt, but our author suggests that the year was made to begin, as we begin it now, about the time, not of the vernal equinox, but of the winter solstice. Eight thousand years amount to about a third part of the *annus magnus*, during which a whole round of precessional change is effected, and the sun eight thousand years ago would be at the beginning of Aries about the time of the winter solstice. This suggestion seems to be a key which unlocks the door to the explanation of many difficulties.

But we must pass on, for our hope is that nearly all our readers will study this volume for themselves. The second chapter is devoted to the constellation Aries and the importance attributed to it in ancient calendars. It is true that the surpassing importance to the Egyptians of the rising of the Nile, which takes place about the time of the summer solstice, led them in early times to transfer the beginning of the year to that season. But every student of Egyptian antiquities is constantly reminded of the prominence assigned on the monuments to the ram, or rather the head of the ram, which marks the position of the two brightest stars in the constellation. Other indications are pointed out from the orientation of the Egyptian temples of the importance attached to the stars of Aries. How this was carried afterwards into Greece is explained in the last chapter of Sir Norman Lockyer's "Dawn of Astronomy," and we may direct attention to two interesting articles by the same writer in NATURE for January 16 and May 29, 1902, on "The Farmers' Years," in which it is shown that not merely temples, but dolmens and cromlechs, were oriented to the sun when half-way between the solstices and equinoxes. Miss Plunket says:—

"As we further study the records of antiquity, now within our reach, it will, I believe, become evident that not only the Egyptians, but also all the great civilised nations of the East had traditions of a year beginning when the sun and moon entered the constellation Aries—such a year as that in use amongst the Babylonians during their long existence as a nation, and such as that which is used by the Hindus in India to this present day" (p. 41).

The ancient Median calendar is next dealt with. Its starting-point seems to have been about B.C. 3000, when the sun was in Taurus at the vernal equinox. The adoption of this by the conquering Assyrians was probably the cause of their fondness for Tauric symbolism and our present familiarity with the Assyrian bull. Miss Plunket thinks that they also adopted in part the religion they found there, on the same principle that induced Sargon, after he had repeopled the conquered kingdom of Samaria, to send one of the former priests to teach the new inhabitants "the manner of the God of the land" (2 Kings, xvii. 26). She contends that Assur, the name of the great god of the Assyrians, is, in fact, a modification of the Aryan word Asura. Several other points are elucidated in the Median calendar, and the cause of the prominence given to some ultra-zodiacal stars, particularly Altair or α Aquilæ.

We now pass on to the Indian and Chinese calendars. When Sir William Jones opened out such a flood of light upon ancient Indian lore, there were many scholars who refused to accept the antiquity of the astronomy of the Brahmins, and would have it that they derived their calendar from the Greeks after the conquests of Alexander the Great. But since that time the spade has effected as great a revolution in archæology as the spectroscope has subsequently done in astronomy. When Sir George Cornewall Lewis pub-

lished his "Historical Survey of the Astronomy of the Ancients" in 1862, he threw cold water upon the attempts which had then been made to decipher the cuneiform inscriptions. He died the year after, just forty years ago last spring; had he survived until now, very different would have been the line which he must have taken. The wealth of the material since accumulated has made it impossible to reject the conclusions of Assyriologists, and though some of the early attempts have necessarily been modified, we have enormous results now in our hands from the library of Assurbanipal and other sources which cannot in the main be gainsaid. The consequences are indirect as well as direct. For if the Assyrian and Babylonian calendars are so ancient, there is no longer any reason to call in question the antiquity also of those of India, or to suppose that they derived this knowledge from the Greeks, who themselves express great respect for the Indian lore.

Now, with regard to the Chineses, if we may follow the obsolete, but perfectly correct, form used by Milton ("Paradise Lost," iii., 438), Miss Plunket's chapter on their calendar-system is worthy, like the rest of her book, of careful perusal. In China the year is now tropical, and does not begin either at the winter solstice or the vernal equinox, but at a time midway between these. But the Gregorian length of the calendar-year was really introduced into that country by some Jesuit fathers who obtained great influence at the Chinese Court early in the seventeenth century. The date used as that of the commencement of the year began much earlier. Their old reckoning was reformed by the Emperor Tchuen about the year corresponding to B.C. 2500, and many indications point to the conclusion that it originally began, like the Accadian calendar, at the winter solstice about B.C. 6000. Miss Plunket comments on the circumstance that this is two thousand years before the creation of man according to the Ussherian chronology, formerly inserted in the margins of our Bibles; but she rightly remarks that a consideration of the variations of the readings in different ancient versions has shown that no reliance can be placed on the Ussher theory, and his dates are accordingly not inserted in the margin of our revised version.

On one point it may be worth while to take exception to a remark by our author about the Julian reformation. There is every reason to believe that it was then known that the true length of the year was several minutes short of 365¼ days, but Cæsar probably thought the insertion of a bissextile every fourth year was near enough for all practical purposes. It was unfortunate that his rule was at first misunderstood. But Pope Gregory, in 1582, not only ordered certain future centurial leap-years to be dropped, but omitted ten days from the calendar that the vernal equinox (and other seasons) might fall as at the epoch of the Council of Nicæa. Miss Plunket concludes these chapters by once more directing attention to the identity of the earliest astronomical traditions of the nations of the east, which suggests matter for reflection. Her book is excellently illustrated throughout, but the second part consists of a series of illustrations of ancient constellations with descriptive letterpress; although we have not space to enter into this at length, we cannot refrain from mentioning the ingenious suggestion that the position of Pegasus was originally upright, the horse striking the vase of Aquarius with his hoof (p. 251). The whole is very carefully printed, and a full index is provided.

W. T. L.

PHYSIOLOGICAL CHEMISTRY.

A Laboratory Manual of Physiological Chemistry. By Ralph W. Webster, M.D., Ph.D., and Waldemar Koch. Pp. 107; 21 plates. (Chicago: the University of Chicago Press; London: William Wesley and Son, 1903.) Price 6*s.* 6*d.* net.

THE introduction to this manual is written by Dr. A. P. Mathews. He dwells upon the rapid development of physiological chemistry, and the efforts which are being made to bring it into closer touch with the biological sciences. He therefore considers it necessary that the science should be presented in a broader way than has hitherto been the case, and implies that the present manual meets this requirement. I therefore proceeded to study the work with considerable expectations of profit, especially when I considered that it was an outcome from the laboratories of the University of Chicago, which have, in recent years, produced so much of original and valuable work in various physiological fields.

I have closed the book with a feeling of great disappointment. The ideal the authors have set before them has not been realised; in fact, it is not often I have read a book which is so full of faults. It has a few good points; every teacher can always learn something from other teachers; the idea of inserting a chapter on the general characters of the cell, taking yeast as an example, is a good one; the directions given for the examination of milk from the sanitary standpoint form a new and useful departure in such text-books. In several other particulars, a competent teacher will glean some useful hints in adding to or amending his repertory of class exercises.

It was, however, for the student that the book was originally written, and for him it is practically useless.

From some points of view the work is a pretentious one, giving information on complex subjects which indicate a desire on the part of the authors to be considered up to date; but this character is lamentably lacking on many questions where one should have expected to find recent and important work described in detail; thus there is no reference to work of Bayliss and Starling on the pancreas, no mention of the distinctions between the euglobulins and pseudoglobulins, and the description of the urinary pigments is hopelessly out of date.

The arrangement of the exercises may be logical as the preface states, but it is absolutely unpractical. For instance, the first exercises the student is set to work out are the preparation of lecithin and cholesterin from the yolk of the egg. The egg may be the starting point of life, but the complicated methods necessary for the obtaining of a complex fat like lecithin hardly

form a suitable introduction to the study of physiological chemistry, but would have come more fittingly after the student knew a little about the nature of the simpler fats. There is, moreover, little or no indication of the relative importance of the substances described; the space devoted to cystin and cerebrin, for instance, is entirely disproportionate to their importance.

The description of the analytical methods is most slipshod; they are usually given in telegraphic or notebook English; they are interlarded with questions, "why is this?" or "what does this mean?" which, in the case of the majority of students, will remain for ever unanswered, for nine out of ten will never take the trouble to "consult this or that text-book," or "ask the instructor," which is the only answer the present work affords.

The omission of small but often important points is not confined to the description of the more complicated methods of analysis, but is seen also in those which are elementary; thus in the directions given for the making of hæmin crystals, the application of heat is omitted; in the description of the Adamkiewicz test, the student is left in doubt as to whether the glyoxylic acid to which the reaction is due is contained in the substance to be tested or the reagents added. In the description of the biuret reaction, no indication is given of its value as a diagnostic test between the native proteids and the products of proteolysis; in the description of the nitric acid test for proteoses, the most characteristic portion of the test, namely, the reappearance of the precipitate on cooling, is omitted; the only experiments relating to blood-clotting are those connected with the inhibitory influence of oxalates; those who follow the directions given for the performance of Hopkins's method of uric acid estimation will fail because of the omission of small details; in Gmelin's test for bile pigments the important detail that *fuming* nitric acid must be used is left out; directions are given for testing for iron in the liver, but no directions for the preliminary removal of blood from the organ; uric acid is spoken of as the result of metabolism of the white blood corpuscles, but the essential fact is omitted that it is from their nuclei, and the nuclei of other cells also, that this substance originates. We are told that ammonium urate is apt to be mistaken for globulin in urine, but no means are furnished of distinguishing the two; and in another part the student is led to suppose that true peptones may appear in the urine. The only method given for the estimation of urea is the hypobromite process, and the apparatus recommended, that of Doremus, is one of the least satisfactory for the carrying out of this test, the importance of which is now mainly historical.

Such are a few of the faults of omission with which the pages abound. Let us next turn to instances of faults of commission, the actual mistakes with which the book bristles. The coagulating points of the muscle proteids are wrongly given, and the most important proteid of all, myosmogen, is altogether left out; histone is classified with the native albumins, and globin with the globulins; for the performance of the biuret test, heating is recommended; in the phenylhydrazine test for dextrose, it is stated that crystals only appear on cooling; indol and tryptophan are spoken of as synonymous; starch is stated to be convertible into sugar by acid in a *few* minutes; in the preparation of serum globulin, water is recommended for washing the precipitate; the sugar formed by the pancreatic juice is stated to be glucose; to obtain the iodine reaction with glycogen boiling with the reagent is the means adopted; the yellow colour of urine is ascribed to a mixture of several pigments not yet isolated, to which are added in brackets the astonishing words "called by Garrod urochrom." Albumose is stated to be a normal constituent of blood; at least that is how I read it, though I admit the passage is so obscure that it might equally well read the other way; the old misstatement that gelatin does not give Millon's reaction is perpetuated; students are led to suppose that the reaction of normal human urine is alkaline; at all events they are told to ascertain whether the alkalinity is due to fixed or volatile alkali; and as a final instance of the careless way in which the book has been prepared, the name of v. Fleischl is persistently misspelt. This does not by any means exhaust the list of glaring errors with which the book abounds, but enough has been said to show that this is an unsafe work to place in students' hands.

W. D. HALLIBURTON.

POPULAR AMERICAN ENTOMOLOGY.

The Insect Folk. By Margaret Warner Morley. Pp. vi+204; illustrated by the author. (Boston and London: Ginn and Co., 1903.) Price 2*s.*

Ways of the Six-Footed. By Anna Botsford Comstock, B.S., Lecturer in Cornell University Extension. Pp. xii+152. (Boston and London: Ginn and Co., 1903.) Price 2*s.*

THESE are two popular publications on the insects of North America, and may conveniently be noticed together, though, except that they are uniform in size and appearance, and are both by ladies, there is little resemblance between them.

The first is for young children, and seems to be intended partly as a reading book, for it is in very simple language, and is mostly in words of one or two syllables, and all long or technical words are explained in a glossary at the end of the book.

We are pleased to see that children are advised to keep insects under observation, and not to kill them, except in the case of those which are injurious.

Neuroptera, Hemiptera, and Orthoptera are the orders dealt with, and the first chapter is on dragonflies, which are more numerous and of more varied colours in America than in Europe.

We may, perhaps, quote one of the longer sentences.

"I once went up the side of a beautiful mountain in North Carolina, where was such a mighty host of cicadas in the trees that I could not hear my companion speak, and a little way off the noise sounded like a torrent of rushing water."

Notwithstanding the simple style of the book, the authoress has contrived to include in it a good deal of information that will be new to most people who are not fairly well acquainted with entomology; and part

of it relates to insects which are found in Europe as well as in America, and it appears to be accurate and trustworthy. We may, however, dispute the statement which we meet with here, not for the first time, that the small cockroach (*Blatta germanica*), called in America the croton bug, "is supposed to have been brought to England by soldiers from the Crimea," if this is supposed to imply that it was then first introduced into England, for it was well known as an inhabitant of most parts of Europe, England included, long before that time, though it may perhaps have become commoner after the Crimean War.

Frequently the information is directly addressed to the children who are supposed to be instructed, as:—

"Mollie wants to know why it would not be a good plan for people who live where there are many mosquitoes to raise dragonflies?"

"That is a very sensible idea, Mollie, and it has been tried."

Mrs. Comstock is already well known as an entomologist, especially as the illustrator of her husband's "Manual for the Study of Insects," &c. Her book consists of a series of ten popular articles on entomology, most of which have previously appeared in magazines. The subjects are "Pipers and Minnesingers" (mosquitoes, cicadas, crickets, &c.), "A Little Nomad" (*Incurvaria acerifoliella*), "A Sheep in Wolf's Clothing" (*Basilarchia archippus* mimicking *Anosia plexippus*), "The Perfect Socialism" (bees, ants, termites and wasps), "Two Mother Masons" (Pelopæus and Eumenes), "The Story we Love Best" (*Ceratina dupla*), "A Dweller in Tents" (*Pantographa limata*), "A Tactful Mother" (Chrysopa), "A Seine Maker" (Hydropsyche), and "Hermit and Troubadour" (Cicada).

The book is written in a popular and attractive, but not childish, style, and is very nicely illustrated. There are forty-seven illustrations altogether, several of which occupy a full page.

OUR BOOK SHELF.

Catalogue of Books, Manuscripts, Maps, and Drawings in the British Museum (Natural History). Vol. i., A—D. Pp. 500. (London: Printed by Order of the Trustees, 1903.)

FEW even of the *habitués* of the Natural History Museum have any adequate idea of the extent and value of the collection of books on natural history (in its widest sense) subjects contained within its walls. Nor is this difficult to account for. Owing to the exigencies of work, the collection is split up into a zoological, a geological, a mineralogical, a botanical, and a general library, the latter containing all those works which treat of subjects belonging to more than one department of the museum. But even this subdivision by no means expresses the real facts of the case, the various departmental libraries being further divided into subsections. For instance, the bird room, the spirit building, the entomological department have each libraries of their own, while even individual officers who have charge of one group of animals possess a collection of books in their own rooms.

In these circumstances there can be no question but that the director has been well advised in recommending the Trustees to sanction the publication of the "Catalogue," of which the first volume is before us, since it is certain that such a series of volumes will be of great interest and value not only to workers in the museum, but likewise to naturalists and bibliographists all over the world.

The collection had its origin in the departmental libraries of the establishment at Bloomsbury, and was largely augmented by purchase, by means of a special Parliamentary grant, at the time of, and subsequent to, the transference of the natural history collections to South Kensington. An important addition was the bequest of the Tweeddale library, some years after the transference. In spite of certain gaps, the collection is believed to be one of the finest in the world. When complete, it is estimated that the catalogue will include some 60,000 entries, the present volume containing about one-fourth of this number.

The editing has been confided to Mr. B. B. Woodward, who, in the present volume, appears to have discharged an arduous task with conspicuous success. Although the work is only an "author-catalogue," many of the entries contain information with regard to the contents of the works, their dates of publication, or other bibliographical detail. It should be added that, on account of their special interest and importance, four subject-headings, namely, atlases, dictionaries, encyclopædias, and gazetteers, have been included. R. L.

A Class Book of Botany. By G. P. Mudge and A. J. Maslen. Pp. xvi + 512. (London: Edward Arnold, n.d.) Price 7s. 6d.

THE scope of this book is somewhat ambitious, for although it is limited to the requirements of intermediate examinations, it takes up in considerable detail the four main branches of botany. Morphology and anatomy are treated in the course of a series of types; classification with special chapters on floral morphology and physiology occupy the second and third parts of the book. Judging by experience, the relegation of morphology to the amount which is distributed throughout the discussion of a series of types is injudicious, because a sound knowledge of external morphology is necessary to the elementary student, partly as a preliminary to anatomy and generally as a foundation for other branches of the subject. It should be pointed out that the authors have not tied down the types to one or two specimens, but, where necessary, additional examples are given; nevertheless, the specific training value of a morphological introduction is wanting. Further, by adopting the type system, the authors provoke comparison with the admirable book written by Dr. Scott, more especially since the cryptogamic types are practically the same in both cases, and Mr. Mudge is not endowed with the same happy power of expression, nor does he display the accuracy which distinguishes the "Structural Botany." The style is, indeed, too rigid, and this only serves to emphasise the numerous mistakes or to give rise to misconceptions. To mention a few instances we find p. 13, "a root . . . always . . . grows downward"; p. 16, "spines have become enlarged and form thorns"; p. 60, "the petiole is polystelic"; and p. 80, a samara is described as a "winged, one-seeded capsule."

Turning to the chapters dealing with classification and morphology of the flower, for which Mr. Maslen is responsible, these are much more satisfactory, and both in choice and arrangement of subject-matter the author's judgment commends itself. The physiological section might with advantage be more practical, and would be much improved by some rearrangement. It is not obvious why the consideration of the absorption of food material by the roots should

be placed after photosynthesis, and after the account of parasites and saprophytes; here it is noticeable that Lathræa is placed amongst carnivorous plants, without any mention of Groom's work. But few practical experiments are suggested, and it would be easy to improve the apparatus depicted in figs. 204, 206, 208, and 219. Finally, the last chapter, in which irritability is discussed, is headed "Movements of Plants," which quite ignores the phenomena of stimulus, and the stimulating source.

In the introduction, the authors state that they have been impressed with the need of a work which should contain all the information which is necessary for certain examinations. On the contrary, the present tendency, and there is much to be said in favour of it, is to bring out smaller books, written by specialists, which deal only with one branch of the subject.

Traité de Chimie physique, Les Principes. By Jean Perrin. Pp. xvi + 300. (Paris: Gauthier-Villars, 1903.)

THIS volume deals with the elements of dynamics, the thermodynamical potential, the phase law and other allied subjects of which a knowledge is indispensable to the modern chemist. The treatment is non-mathematical, but the author indulges in a good many discussions of a philosophical character. In defining the scope and aim of physical chemistry, he refers to the old style of thinking, according to which physics was the science of reversible phenomena, and chemistry the science of irreversible phenomena. The notion of *force* is defined by means of the extension of a stretched elastic string or wire. Why should not this treatment be adopted in books where relations involving mass and acceleration do not play a prominent part? We notice, as a useful feature, that Lord Kelvin's definition of absolute temperature is dealt with at some length. In the preface the author rightly directs attention to the desirability of abandoning such misleading notions as that of absolute in contradistinction to relative velocity, the statement that "heat cannot pass from a cold to a hot body," which is like speaking of an apple passing from one hand to the other, and the prevalent confusion of language in speaking of ideas involving force and energy.

The Arithmetic of Elementary Physics and Chemistry. By H. M. Timpany. Pp. 74. (London: Blackie and Son, Ltd., 1903.) Price 1s.

THIS collection of numerical exercises is very limited in its scope. It is composed of four sections; one includes problems on relative densities, another is devoted to examples on moments and centres of gravity, a third is concerned with the conversion of thermometric scales and with specific and latent heats, while the last deals with the calculation of the weights and volumes of the substances taking part in chemical reactions. Typical examples are worked out for the guidance of the student.

Gisements minéraux. Stratigraphie et Composition. By François Miron. Pp. 157. (Paris: Gauthier-Villars and Masson et Cie, n.d.)

M. MIRON here provides geologists and others with a compact account of numerous non-metalliferous mineral deposits which are useful in numerous branches of technology. A previous volume in the series known as the "Encyclopédie scientifique des Aide-Mémoire," to which the present book also belongs, dealt with those minerals in which the metallurgist is particularly interested, and attention is here chiefly directed to the natural sources of sulphur, nitrates, phosphates, borates, compounds of the alkali and alkaline earth metals, and other minerals.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Human Science and Education.

THERE surely never was a time when there was more need for consideration of the root-principles of higher education. It is generally allowed that we in England are behindhand in the matter, that we have allowed the Germans and Americans to have the start of us. And awaking to this conviction we have a difficulty in seeing in what direction we should move in an attempt to recover our lost ground.

I accede with pleasure to a suggestion of the Editor of NATURE that I should endeavour to lay before his readers some of my views as to the direction in which those studies which have *man* for their subject should move. At first sight it might seem that the present place is inappropriate for a paper of this kind. Yet it is among the students of nature that my contentions as to the study of man are perhaps most likely to find support.

What I plead for is that the two great branches of knowledge, the science of nature and the science of man, should be brought nearer together, that it should be recognised how much they have in common, and that the reasonable votaries of both should make common cause against the same enemies.

The enemy in higher education of the science of nature is the technical spirit, which will not take a wide outlook, which ties all investigation down to narrow points of practice, which does not see that breadth of study and imaginative insight are necessary in our schools of science if we would produce men of real efficacy for the work of the world and not mere technical experts. The enemy of the science of man is the spirit of convention, which is dominated by rhetoric and commonplace, which has no ambition to see the facts of human nature and of history as they really are, but interprets them by tradition by self-interest, by sentiment. And between these two enemies of the children of the light there springs up a natural alliance. The man who has received a narrow technical training may be a good linguist or the like, but is not likely to appreciate a wide humanistic culture. The man who has received a merely conventional literary education may master technical details, but will scarcely understand how the steady growth of science, of ordered knowledge, has changed our whole way of regarding life, religion or society. The two enemies will combine when they can to keep education at its present level, and to ridicule all attempts to provide a really scientific training in universities and schools.

It is scarcely necessary to say much in these days as to the importance of a thorough organisation of the study of nature and natural forces in our colleges. There has been in this matter extraordinary progress in the last thirty years. At any rate it would be an impertinence for me, who have never been trained in any branch of natural science, to dwell on this matter. But while natural studies have moved forward rapidly, those which concern man have in our universities scarcely moved. The course in humanity, and in modern history, is at Oxford almost exactly what it was thirty years ago. Cambridge is less averse to change than Oxford, and has been more mobile; yet it may be doubted whether human studies have imbibed much more of the modern spirit in Cambridge than at Oxford. In the new universities which are springing up on all sides, generally speaking the side of natural science is more or less well developed with teachers and apparatus, but in the matter of history, psychology, archæology and the like they are much to seek. In the case of the new University of London, one sees the germs of better things. Several of the schemes of study there arranged look well on paper. Only funds are needed to set the machine in motion. In London there are great institutions, like the Record Office and the British Museum, which are in the nature of things obliged to be scientific, and one hears great things of the London School of Economics.

I think the readers of NATURE will admit that the slow-

ness and incompleteness with which reorganisation is going on in the studies concerned with man is an undesirable, even a dangerous, fact. The disparity between the two halves of human knowledge has grown so great that there is a fear that almost all young men of original or inventive mind will turn to the study of material nature. It would be foolish to make any comparison between the importance of the knowledge of man's surroundings and the knowledge of his nature, his works, and his history. Both are beyond value. But if the two halves of the human brain, so to speak, work on different plans, what will become of the unity of man himself?

A reason why the votaries of natural science should have some sympathy with those who are endeavouring to remodel humanist studies is that it is from the natural sciences that methods and ideas have flowed into those relating to man. The ideas of continuity, of adaptation to environment, of evolution, were transplanted into historic studies from those of biology, and it was soon found that they flourished almost as well, and bore almost as much fruit, in the new field as in the old. But whereas the highly trained and scientific worker in history, psychology, archæology, and kindred studies is quite alive to the use of the new scientific methods, they have as yet only partially affected education in these subjects, even in our universities. The books used by the students are changed in character, but not the ways of working. Undergraduates are not thoroughly taught the principles of weighing evidence, they are not accustomed to work on the comparative method, they do not acquire historic imagination. They have not learned to judge by evidence rather than by authority, nor rigidly to distinguish degrees of probability.

Of course, education is not, and cannot be, only scientific. To everyone's education there should be other sides. There should be a religious side, in some ways the most important of all. There should be an artistic side. Every boy and every girl should be taught to draw or to play some instrument, and to appreciate good work done in the art which is thus practised. And every student should be taught to use the English language to some purpose, and to appreciate what has been best written in that language, and in one or two other languages. But at present I am not speaking of religious, of artistic, or of literary education, but of scientific education, of the direct training of the faculties for dealing with the facts of the world; and it is my contention that this scientific side of education has been comparatively neglected in the case of those who have not taken up some branch of physical science. In fact, so completely has the really scientific character of such studies as history and archæology and economics and the like been, at least in this country, overlooked that when we hear of a man studying science it is at once assumed that he is giving his attention to the facts of the natural rather than of the human world. But the word science has not and cannot rightly have any meaning but "ordered knowledge." Whatever can be surely known is matter of science.

But I must come to the practical question of the organisation of study, and especially of university study. Knowledge of the physical world has so greatly grown by two things, the improvement of method and the organisation of research. Improved methods of investigation in the study of man and of history have fairly come in: they are scarcely yet fully recognised in schools and universities, but the best authorities in the various branches of the subject are acquainted with them. What is most needed is a new organisation of research.

At present in our universities the spread of better methods in the human studies has principally effected this, that the student works on better text-books. This in itself is something, but not very much. Compare, for example, such a subject as geology. Would it be regarded as sufficient if the students of geology read books in which the latest and most approved views are expressed? Surely not; until the student has grubbed for himself in the chalk pit and the cliff, and learned in museums to recognise the substances belonging to various strata of the earth, he has done nothing worth doing. He must not take results ready made, but must work for himself, see for himself, learn the value of evidence and the touch of fact. I venture to think that the case is the same in human studies. Here also it is of little use to accept the best results, unless the student grasps the grounds on which they are reached. Here also he must for himself work on the data, see why one view is more probable than another, map out the exact state of the evidence.

Our remedy is to adopt in the human sciences organisation and methods of study which have triumphed in the natural sciences. In every college and university there should be, beside the laboratory of the chemist and the dissecting room of the physiologist, work-rooms for the students of man. As regards psychology and anthropology, which are two foundation stones of the arch, this is already conceded. Specimens and apparatus are there acknowledged to be necessary. The same necessity exists as regards other branches of human study. Work-rooms are needed in which the student should be, so far as possible, brought into contact with evidence. All the important books, dictionaries and the like should, of course, be there. And besides, the authorities for the books should be so far as possible put together, facsimiles of documents and of inscriptions, maps, chronicles, coins, seals, and the like. In the economic section every kind of statistics should be at hand. In the department of ancient history there should be casts of inscriptions, photographs of sites, facsimiles of manuscripts, casts of statues and of coins. Even when such objects are not direct authorities for the points of which the student is in search, they form his mind by bringing him into contact with fact and evidence, and they greatly stimulate his imagination by placing him in presence of some of the surroundings of history. The result of work of this kind would be a change of outlook and of method, the substitution of investigation for theory, of science for fancy. It would prepare the student for wider work in the actual world, for which, of course, it would be no substitute but a *propaedeutic*.

Those who teach and organise natural studies are fully alive to the great demands made by the changed state of the world, and are demanding endowment with energy and persistency. They are quite right. But the teachers of human studies are more inert and less keenly alive to the need of expansion. But science, ordered knowledge, is, in spite of all divisions, one, and it will be a great misfortune for the country if in the extension and re-endowment of our university system the necessity of thorough and elaborate investigation of man in all his aspects, his history and his works, falls into the background.

Oxford, October. P. GARDNER.

Uniformity in Scientific Literature.

IN 1894 a committee was appointed by the British Association to inquire into the question of uniformity in the size of the pages of proceedings, transactions, and scientific journals in which original papers are published. The appearance of a number of *Proceedings* of the London Mathematical Society of a different size from its predecessors, in accordance with an announcement circulated as recently as the end of August, suggests that it may be desirable to direct attention to the report of this committee (Brit. Ass. Rep., 1895, p. 77).

In this country all the more important octavo journals in question are printed on either medium or demy paper; as examples we may cite the Royal Society's *Proceedings*, the *Philosophical Magazine*, the *Proceedings* of the Physical Society, &c. A considerable number of foreign journals (*e.g.* Wiedemann's *Annalen*) are of practically the same size. The difference between medium and demy octavo is too small to cause any inconvenience either in placing the volumes together on a shelf or in binding together reprints of papers. In the case of certain American and Italian journals a somewhat larger sized page has been adopted, but the difference is entirely in the margin, the printed portion being in some cases smaller even than in our demy octavo journals. This allows of reprints being cut down for binding with others from the *Philosophical Magazine* or British Association *Report*, and still leaving plenty of margin. Where papers are too long to be published in octavo form, medium and demy quarto are the most prevalent sizes. Here again there is not much to choose between the two, and, as in the case of octavo, the committee decided to recommend the demy size as a standard. The most inconvenient pamphlets to deal with are those in which the paper is too small for binding up

with demy quarto, and the printed page is too large to allow of the paper being cut down to demy or even medium octavo size. The *Atti* of the Lincei Academy may be cited as an important example. Fortunately, however, such exceptions are comparatively few in number, and they include none of the main English journals in which original papers are published on mathematics or physics.

It is my hope that by again directing attention to this matter further uniformity may be secured in the sizes of proceedings and transactions by the gradual elimination of inconvenient sizes, and by the avoidance of further divergences. The size of the new number of London Mathematical *Proceedings* is peculiarly unfortunate, as it is not uniform even with those outstanding foreign journals which do not conform to the recommendations of the committee.

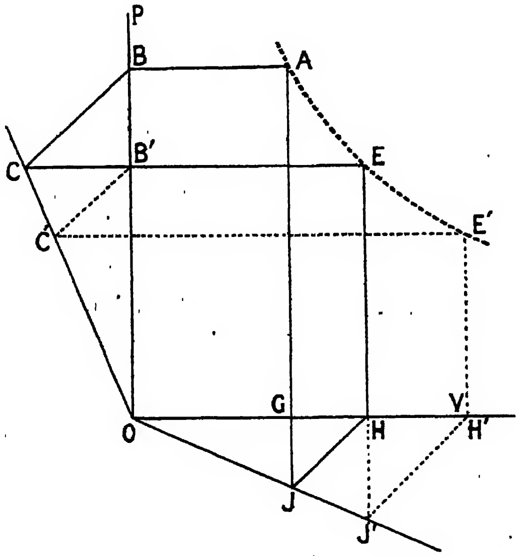
G. H. BRYAN.

Expansion Curves.

MR. STODDART's method of finding points on the curve pv^n = constant, to which Prof. Perry directed attention on October 8 (p. 548), is interesting, but it does not give a great number of convenient points on the curve. If the points A, E, . . . are called (v_1, p_1), (v_2, p_2), . . ., the values of v and p form two series of quantities in continued proportion, *i.e.* such that $v_1/v_2 = v_2/v_3 = \ldots$, and $p_1/p_2 = p_2/p_3 = \ldots$

A modification of the method, bringing out more clearly its essential simplicity, and, moreover, far easier in practice, would be to calculate the positions of *two* points A, E instead of finding A and the specially related angles α, β.

It will then be seen from the diagram, by drawing the lines needful to find a third point (say for definiteness in



the direction of increasing v and decreasing p), that the method advocated is only that of finding the above two series of continued proportionals, and that *any* angles would serve the purpose, all that is necessary being that all the construction lines like JH must be parallel to each other, and similarly all the lines like BC parallel to each other. But no modification of the method will give more than the points I have indicated.

By drawing the tangents at the points so found, the accurate construction of the curve would evidently be facilitated. This can be neatly done by taking care in the choice of the first two points; for in these curves the gradient is $-p \div v/n$, so that the tangent at the point (v,p) cuts the axis of x at the point the abscissa of which is $v(1+1/n)$. Hence if we choose the first two points (v_1, p_1) and (v_2, p_2) so that $v_2 = v_1(1+1/n)$, the tangent at the first point will pass through the foot of the second ordinate, and similarly the tangent at the second point will pass through the foot of the third ordinate, and so on.

Or, if we take $v_2 = v_1\sqrt{(1+1/n)}$, so that $v_3 = v_1(1+1/n)$, the first tangent will pass through the foot of the third ordinate, and so on.

This happens to be approximately the case in Prof. Perry's diagram, which for convenience has been reproduced here with a set of additional construction lines.

Coopers Hill. ALFRED LODGE.

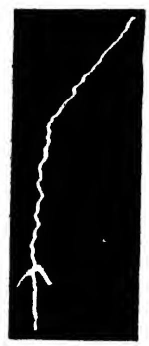
Rocket Lightning.

A PECULIAR species of lightning, bearing a strong resemblance to ascending rockets, was witnessed on the evening of July 22 by two of the professors in Sibpur Engineering College, Howrah, near Calcutta, one of whom wrote me the following careful account in a letter dated the next day. I wrote back suggesting local inquiry in the direction in which the phenomenon appeared, and sending some extracts from Hann's "Lehrbuch der Meteorologie" bearing on the subject. The reply, dated September 1, shows that the suggested inquiry is impracticable.

11 Leopold Road, Ealing, W. J. D. EVERETT.

WE saw some strange lightning yesterday evening at about 9 p.m. It was a clear, moonless night, with just a bank of cloud very low in the S.S.W., with a well-marked edge, height say from horizon (flat) to 5° up. There was a misty cloud above this. These clouds we could only see properly when the flashes came. Stars were visible at about 10° above the horizon at this point, and the sky was quite clear all over elsewhere. Now and then flashes showed from behind the lower cloud (the flashes themselves were mostly hidden, and thunder was not audible). The flashes were not so frequent as usual, say one per minute or so. Generally here they are almost incessant during thunderstorms.

At intervals of three minutes or so, immediately after a flash—which, as common here, was mostly multiple, lasting a second or so altogether—a luminous trail shot straight up to 15° or so, about as fast as, or rather faster than, a rocket, and of very similar appearance, but with minute waves, like ribbon lightning. It was hardly as bright as most lightning. S. and I saw it repeated seven times, and Prof. Brühl (physics) three or four times after we directed his attention to it. He was equally surprised at the novelty, and he has been out here some eighteen years. One of the trails turned off, as shown; the others were about vertical as seen from here. Each grew up steadily from below, and then disappeared at once. The upper end was definite, and did not branch or spread.



In each case it followed immediately on a vivid flash or set of flashes. It was certainly not fireworks of any kind. It terminated in apparently clear sky. Its appearance as a uniformly and very bright ribbon was different from any fireworks. It was somewhat yellowish, not purple as lightning often is. It was much too far off for fireworks to be so high and bright. No thunder was audible.

July 23. W. H. EVERETT.

THANKS for trouble of making extracts from Hann *re* lightning, which, as you say, describe phenomena different from what we saw.

Peake is in charge of the Meteorological Office for India, and did not hear about it, nor did I see anything in the Calcutta newspapers.

There would be practically no Europeans or any competent observers nearer the lightning than we were; as it must have occurred at a spot above the Sunderabunds, a wilderness of waterways and jungle. And there are probably not a score of men in all Bengal who would take serious interest in such lightning if they did happen to see it. I was lucky to have Brühl as a witness, he being an old resident, and one who keeps his eyes open.

It was not like a string of fireballs, for it was of uniform width. But it had, as Hann says of globular lightning, doubtless some connection with the breaking down of the air by the volleys of discharges. W. H. E.

September 1.

Our Winters in Relation to Brückner's Cycle.

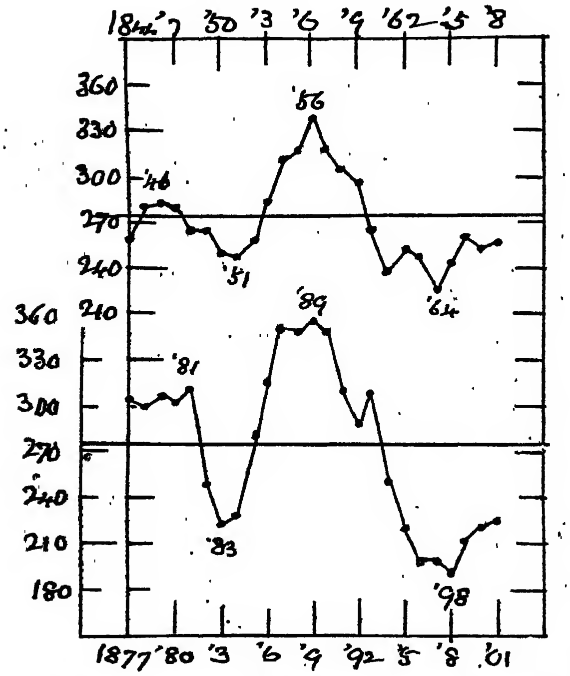
IT was said in Bacon's time that every thirty-five years "the same kind of suite of years and weathers comes about again" (see his essay "Of Vicissitude of Things"), and the important researches of Brückner on this subject are now receiving considerable attention.

The value, 35 years, as used by Brückner, is, of course, an average. The interval from centre to centre of his cold and wet periods (or the opposite) is sometimes as much as 40, sometimes as little as 30. It has been noted, further, that 35 is very nearly three times the sun-spot cycle of 11·1 years.

Now if we look into the variation of certain weather-elements at Greenwich since 1841, it may, I think, be truly said to-day that the same kind of weather has come round again after about 33 years. Let us take *e.g.* our winter seasons as measured by the total number of frost days from September to May.

In the upper curve of the diagram herewith, each year point represents the sum of frost days in five winters so understood; the first (1844) for winters ending 1842–46, the second, winters ending 1843–47, and so on.

Similarly, in the lower curve, each point represents a five-winter group, but thirty-three years later, commencing



Curve showing the variation of frost days from five-year sums for the period 1842—1902.

with 1877, and ending with 1901 (which includes last winter).

There is obviously a general correspondence between these curves; high values in one matched with high values in the other, and low with low. Twenty-five pairs of values being thus compared, there are only four in which the members of the pair are on opposite sides of the average line (273).

Again, we have, in general,

Diminishing cold	1846–51 (5 years)
	1879–83 (4 ,,)
Increasing cold	1851–56 (5 ,,)
	1883–89 (6 ,,)
Diminishing cold	1856–64 (8 ,,)
	1889–98 (9 ,,)

From these last dates there is a rise.

The earlier curve might thus be considered a kind of programme for the series of winters commencing 33 years after the first. It will be interesting, I think, to see how far it continues to be so in the future.

The winters about 1856 and 1889 appear to have been conspicuously cold times. We might, perhaps, anticipate another such time in the early 'twenties, the curve not rising so high between, though, of course, individual winters might be very severe. This seems to be suggested by the course of the curve after 1868, but the correspondence may perhaps fail.

Other examples of such recurrence, corresponding more or less closely, might be given. The long record of Rothesay rainfall (from 1800) will be found worth treatment in this way; conspicuously dry times occur about 1822, 1855, and 1887, and the smoothed curve from 1835 to date may be said to repeat in its main features that from 1802 to 1867.

ALEX. B. MACDOWALL.

An Ant Robbed by a Lizard.

THE following account of the robbery from an ant by a lizard may interest some of your readers.

While walking along the main road on the outskirts of Bordighera yesterday morning, I noticed a strange-looking insect moving across it in a peculiar way. On getting nearer, I saw that what had attracted my notice was a black ant—about an inch long with brown wings—dragging a cricket bigger than itself. It held the cricket by the head, and as the ant moved backwards it drew the cricket towards it. While doing so it entered the shadow cast by my umbrella, and instantly released its hold and got out of the shadow, but finding there was no danger it returned and seized its prey again by the head, and recommenced its backward movement. A low wall ran alongside the road, and when the ant got within six feet of it a common brown lizard appeared on the top of the wall and evidently soon caught sight of the ant, for it ran quickly down the wall and to within two feet of it, when it crouched for a second or two like a cat ready to spring, and then charged the ant, apparently butting the cricket free with its head. Before the ant could regain its hold the lizard seized the cricket in its mouth, and darted up the wall in the direction from which it originally appeared on the scene, leaving the ant running round and round, moving its wings in an agitated manner, vainly searching for its lost prey.

J. W. STACK.

Villa Mona, Bordighera, September 1.

A NEW MECHANICAL THEORY OF THE ÆTHER.[1]

THIS memoir was communicated to the Royal Society in February, 1902, and has now been issued in the dual form of a contribution to the *Philosophical Transactions* and a volume of Prof. Osborne Reynolds's collected papers.

It may safely be described as one of the most remarkable attempts that have been made of recent years to formulate a dynamical system capable of accounting for all physical phenomena at present known. A theory such as is here set forth may not improbably play the same part in modern science that was assumed by the atomic theory and the kinetic theory of gases in the science of the time when these theories were propounded.

If we suppose the ultimate particles—Prof. Reynolds calls them "grains"—constituting the material universe to be either spheres, or what comes to the same thing, point atoms behaving in the same manner as uniform smooth spheres, then it is impossible to assume these grains to be of equal size and distributed at random through space without assuming them (as in the kinetic theory of gases) to be in motion among themselves. On the other hand, a medium in which the motion of the different grains among themselves partakes of the nature of diffusion does not lend

[1] "The Sub-Mechanics of the Universe." By Osborne Reynolds, M.A., F.R.S., LL.D., M.Inst.C.E. Pp. xvii + 256. (Cambridge University Press: Published for the Royal Society of London, 1903.) Price 10s. 6d. net.

itself kindly to the explanation of such phenomena as the propagation of transverse waves. The medium considered in the present investigation is assumed to consist of uniform spherical grains which are so close together as to prevent diffusion, and when in a state of "normal piling" the centre of each grain is supposed to be equidistant from those of twelve neighbouring grains, this being the distribution corresponding to minimum volume, and the system "constituting to a first approximation an elastic medium with six axes of elasticity symmetrically placed." [It may be pointed out before proceeding further that there is more than one way of piling balls so that each ball is in contact with twelve neighbouring ones and the total volume is a minimum.]

The grains are supposed to be capable of limited relative motion, and local inequalities may exist due to the presence or absence of a number of grains above or below that necessary for normal piling. In such cases singular surfaces are formed between the grains in unstrained and those in strained piling. The author finds that the local negative inequalities produced by the absence of grains present the ordinary properties of matter. They are free to move through the medium without resistance, the grains streaming freely through their singular surfaces, and they attract one another according to the law of the inverse square. The density of matter is thus negative, taking that of the medium to be positive, and if the density of water be taken as -1, the author finds that of the medium to be 10^4. The diameter of the grains in C.G.S. units is 5.534×10^{-18}, their mean path is 8.612×10^{-28}, their mean relative velocity is 6.777×10, the mean pressure is 1.172×10^{14}, the rate of propagation of the transverse wave is 3.004×10^{10}, and the rate of degradation of the transverse wave is such that it would require 56 million years to reduce the total energy in the ratio of 1 to e^2. The absorption thus produced is of such a magnitude as to account for the blackness of the sky on a clear night compatibly with the absence of any measurable absorption of light by the ether. On the other hand, the absence of any evidence of normal waves until quite recently is accounted for by the conclusion that the rate of degradation of the normal wave would reduce its energy to about one-eighth in 3.923×10^{-6} of a second, or before it had traversed 2200 metres. In addition to positive and negative inequalities of which the latter correspond to matter, the existence is assumed of "complex inequalities" due to the displacement of grains from one position to another, and a comparison of the attractions of such inequalities with those due to the inequalities representing matter is in complete accordance with the known smallness of gravitative as compared with electric action.

The theory accounts for the refraction, dispersion, polarisation by reflection, metallic reflection and aberration of light.

The analytical investigation is based on the general equations of motion and conservation of any entity (Section ii.), these equations being generalisations of the well-known equations of continuity of hydrodynamical and allied systems; the formation of the equations of motion in a purely mechanical medium (Section iii.), the separation of the motion into its components of "mean" and relative motion (Sections iv.–vii.), the extension of the kinetic theory to granular media (Sections viii.–x.), and an elaborate analysis of the changes taking place in the angular inequalities, the momentum and energy, the mean and relative systems, and the mean inequalities and their motions (Sections xi.–xiv.). It should be observed that the present theory involves the assumption that positively electrified bodies do not repel each other, and for this the author gives arguments in § 226. In the final section (xv.) the numerical values of the quantities which define the condition of the granular medium, as stated above, are deduced from the results of physical experience.

The mathematical reasoning is very difficult, in some places almost impossible, to follow, owing to the large number of doubtful points or inaccuracies in the equations. Even if the fundamental conclusions should prove to be correct, there are many points in the argument which are at present obscure, and require to be cleared up. To take a few examples, in equation (4), p. 10, a new symbol r is introduced without any explanation, and the dual use of δ is very confusing. Having used δS to denote a volume element, and δs a surface element on this page, the author suddenly changes from δS to δs in the first of equations (20) on p 16, and to ds in the second and third, although he refers to equation (2) of p. 10, which involves δS. On p. 13 in equation (13), the differential is omitted after the treble sign of integration; also in (16) one of the expressions under the sign of summation is multiplied by the differential element dS, while the other is not; in the former equation the reader will naturally supply the missing $dx\, dy\, dz$, but the meaning of the latter equation is obscure. Again, turning to p. 105, we find that § 116 refers to "The mean velocities of pairs having relative velocities $\sqrt{2}V_1'$ and $V_1'/\sqrt{2}$," while in § 120 we read, "Since the mean velocities of pairs of grains having relative velocity $\sqrt{2}V_1'$ is $V_1'/\sqrt{2}$ . . . ." In § 117, "All directions of mean velocity of a pair are equally probable whatever the direction of the mean velocity." On p. 120, equation (181), it is not easy to see how, if N be equal to the number of grains in unit volume, the square root of N should be equal to N $dx\, dy\, dz$ multiplied by a certain function of the coordinates, nor how by integrating the equation with respect to y and z the square root of N now becomes equal to N multiplied by another function multiplied by the linear differential dx. In ordinary circumstances there is no useful purpose served in filling a review with a list of *errata* which any reader could easily correct for himself. But the present investigation would be difficult to follow even under the most favourable conditions, and the presence of so many formulæ and statements which cannot possibly be correct as they stand renders the task well nigh hopeless.

An objection of an entirely different character applies to the sections in which Maxwell's law of distribution of velocity components and partition of energy is extended to a medium of closely packed spheres such as that considered by Prof. Reynolds. A great deal has been written as to the validity of Maxwell's law, and of the fundamental assumptions involved in the proofs of it. The general opinion on which all mathematical physicists are pretty well agreed is that the law holds good to a first approximation in gaseous media the molecules of which are not too closely crowded together; but one method of proof after another has on closer examination been found to involve some assumption or other which usually breaks down in the case even of a dense gas. Moreover, Mr. Burbury has gone so far as to establish a different formula for the law of distribution in dense gases. To assume the law to hold good in the extreme case of a medium the ultimate particles of which are permanently interlocked must be regarded, failing other evidence than that given by Maxwell, as a very doubtful step.

A number of interesting questions suggest themselves for the consideration of physicists, such as the ultimate distribution of energy between the grains and molecules, the determination of the temperature of cosmic space as defined by the mean kinetic energy of the grains, the influence of the absorption of the medium, however small, on the progress of cosmic

events, the existence of directional properties of the ether determined by the regular arrangement of the grains, and the finity or infinity of extent of the medium. It may be confidently anticipated that Prof. Osborne Reynolds's granular medium will play an important part in the physics of the future. It is, however, to be hoped that the subject will receive careful and critical study in the hands of numerous mathematical physicists, and that it will not be left for the experimenter and philosopher blindly to accept Prof. Reynolds's doctrines as the basis of speculations about things which they do not understand. The practice of assuming statements to be true because Maxwell made them has been too prevalent in the past, and there is not very much difference between those who adopt this attitude and writers who publish papers at their own expense to show that the earth is not round or that gravitation does not exist. The dogmatic statements of the former class of philosopher often afford plenty of material for the abusive attacks of the latter.

G. H. BRYAN.

THE EFFECT OF EDUCATION AND LEGISLATION ON TRADE.

IN his second presidential address to the Society of Chemical Industry at its annual meeting held in Bradford, Mr. Levinstein again addressed himself to the subject of education. He thinks that almost too much importance has been attached to education as being the *only* factor which has caused the industrial progress and superiority, in certain classes of merchandise, of Germany in comparison with this country. Attention is therefore directed to other considerations which he considers have also to be taken into account, such as the unification of the various German States after the Franco-German war, which, of course, gave an internal free trade to the German nation, the nationalisation of the railways and canals, and the protective patent laws.

He then refers to America, which he does not consider to be a better educated country than our own. Naturally the new Education Act of 1902 comes under review. Mr. Levinstein is doubtful, as are many others, if the Bill will advance secondary education, because the number of persons appointed to the councils who represent secondary education is exceedingly small. No remark is made upon another aspect of the case, namely, that a great many of those appointed know practically nothing about primary, and still less about secondary education. In some cases which have come before our notice, persons of little education (beyond their own inflated opinion of themselves), but desirous of local fame, and having plenty of "push," have brought themselves forward and been elected, while those who really are educated, and know what education means, have been passed by.

The raising of secondary education to a really high and uniform standard will be extremely costly. But the expenditure on primary education, according to the provisions of the new Act, will absorb such a large amount of the ratepayers' money that they will be disinclined to incur further expenditure in order to make it really efficient. No student can enter a German technical college without passing an extremely searching and thorough examination. In Great Britain the total number of students, from fifteen years and upwards, taking complete day technological courses is 3873; probably not more than 10 per cent. could pass the entrance examination of Charlottenburg.

As an illustration of what Manchester is doing in the way of technical training, Mr. Levinstein gives an account of "the department for preparing, bleaching, dyeing, printing, mercerising and finishing textiles, together with the manufacture of paper." There is no dabbling here with manufacture in a test tube, such as we see in some of our educational institutes. The department is lodged in a separate building, apart from the school of technology. It is fitted with the latest and most up-to-date machinery, taken from this country and abroad. As all the machinery is driven by separate motors, there will be no difficulty in replacing it, as it becomes out of date and obsolete, by means of newer and more modern machinery.

In this country we excel in the production of first-class yarn and cloth, made from first-class raw material. These goods will always fetch a good price. But within the last quarter of a century a demand has sprung up for cheap imitations, made from inferior materials, but which must have the external appearance of the first-class article. It is in the weighting of silk, the intermixing of fibres and the manufacture of imitation velvets that the foreigner excels. But the demand is enormous, and if we would hold our own in the markets of the world, we must learn how to manufacture these cheap goods. The British manufacturer must learn to adapt himself to the times and to the tastes and wishes of the consumer.

Manufacturers have often refused to employ chemists, except as "testing machines," because the chemist is so often only a theorist, sometimes not even that, and understands absolutely nothing about machinery. This excuse will, however, soon be no longer tenable. Students who have passed through the department just mentioned at the Manchester Technical School should be fully qualified to take a position not only in dye, bleach, print, mercerising, or finishing works, but also in paper mills. They will have not only a knowledge of chemistry, but also of machinery. It is a pity that technical institutes do not make it compulsory for those who intend to become works chemists to include in the syllabus a course in engineering, both practical and theoretical.

Referring to the "Patent Law Amendment Act," Mr. Levinstein has great hopes that satisfactory results will accrue to our manufacturers. The chief clause in the Act, and one for which British manufacturers have been agitating for many years, is that which deals with the granting of licences. Hitherto the foreigner could patent anything he chose, manufacture it abroad, and "dump" it down here, without his being under any obligation to manufacture it on British soil. And it was a matter of great difficulty to compel him to grant a licence to a British firm to manufacture the goods. Under the new Act, if he does not manufacture in this country, he can be compelled to grant a licence for the manufacture of the product, or failing this his patent may be declared void.

It is only after more than twenty years of agitation that this Act has been passed. Mr. Levinstein reviews the pioneering work which had to be done before the inertia of the Board of Trade was overcome.

Finally, the difficult and vexed question of foreign tariffs is dealt with. Mr. Levinstein considers that the reasons we have not made greater headway, so far as our export trade is concerned, are:—our education has been at fault; our patent laws were bad, and foreign tariffs have often been prohibitive; and we would add the want of adaptability of some of our manufacturers. The Government is also exceedingly slack in making known to our traders, at the earliest moment possible, changes in foreign tariffs. Interested Continental traders learn at once, through their Minister of Commerce, not only changes which have taken place, but changes which are contemplated. But the wheels of our Government, in respect to information which may

be of vital importance to the traders, move so exceedingly slow. The fact is, we require a Minister of Commerce with a competent staff, and the sooner the Government awakes to the fact the better for the country.

F. MOLLWO PERKIN.

NOTES.

IT is probably known to some that a project has been started, and is already well advanced, to found a prize for physics at St. Peter's College, Cambridge, as a tribute to the memory of the late Prof. Tait, of Edinburgh, honorary fellow of the college. Besides members of the college who have heartily taken part in the enterprise, many friends of Prof. Tait, both in Belfast and Edinburgh, have recorded their appreciation of him and of his great services to the advancement of science by joining in this memorial of him at the college of which he was so brilliant a member; and it is believed that others, if they were made aware of the proposal, would desire, for a like reason, to be associated with it. Mr. I. D. H. Dickson, St. Peter's College, Cambridge, will reply to any inquiries, and until more formal thanks are made by the college, will gratefully receive and acknowledge any donations that may be sent to him for the purpose of the memorial.

IT is expected that a monument to the electrician, Zenobe Gramme, will shortly be raised in Brussels. Owing to the efforts of M. Léon Janssen, the general manager of the tramways of Brussels, a committee has been appointed to accomplish this purpose.

WE learn from the *British Medical Journal* that the proposal of the German committee of the Virchow memorial to erect a statue of Virchow in one of the public streets of Berlin, near the place where his scientific work was conducted, will be carried out. Contributions towards this memorial should be sent to the Bankhaus Mendelssohn und Cie, Berlin, W., Jägerstr. 49, 50. An obelisk of unpolished grey granite has been placed over Virchow's grave in the old Matthäikirchof, Berlin. It bears on one side a black marble tablet, on which is inscribed "Rudolph Virchow," and the date of his birth and death.

WE regret to see the announcement of the death, in his seventy-first year, of Prof. Rudolf Lipschitz, the professor of mathematics at the University of Bonn.

THE death is announced of Prof. Alexander Rollet, of Graz, in his seventieth year. He was educated at Vienna, but was deeply influenced by Ludwig, and devoted himself especially to the physiology of the blood and muscles. He was called to Graz in 1863, and was four times rector of that university.

A MESSAGE from Rome, through Laffan's Agency, dated October 20, states that Mount Vesuvius is again active, enormous globes of steam being emitted from the principal crater, accompanied by incessant subterranean rumblings and explosions. A stream of lava is flowing down one side of the volcano.

THE Odontological Society of Great Britain announces that it is prepared to receive applications for grants in aid of the furtherance of scientific research in connection with dentistry. For particulars and forms of application inquiry should be made of the honorary secretary, Scientific Research Committee, Odontological Society, 20 Hanover Square, London, W.

THE new college farm established at Madryn, midway between Aber and Llanfairfechan, in connection with the Agricultural Department of the University College of North Wales, was formally opened on October 17 by the Earl of Onslow, President of the Board of Agriculture. In the course of his inaugural address, Lord Onslow advocated the desirability of giving greater attention to forestry in this country.

FOR a long time plague has been endemic in Hong Kong, the disease reappearing after a period of intermission in an inexplicable manner. Prof. Simpson has lately pointed out in a report to the Colonial Office that domestic animals and poultry may contract plague in a latent form from feeding upon plague-infected material, and has suggested that infected food may be a potent source in disseminating the disease. According to the *Times* (October 17) Sir Henry Blake, the Governor, has recently instituted an investigation of the inhabitants and vermin of a large native quarter in the colony certified to be free from plague. This has revealed that a considerable number of the bugs, fleas, spiders and cockroaches contain plague bacilli. Samples of blood from supposed healthy natives upon examination showed the presence of plague bacilli in 5 per cent. of the specimens. Under favourable conditions such infected persons and vermin become possible sources of danger, and sporadic outbreaks must be expected while they are present. It is difficult also to see what measures can be taken to eradicate the disease in these circumstances.

IN the course of the Harveian oration delivered before the Royal College of Physicians on Monday, Dr. W. H. Allchin referred to recent work on radio-activity and the constitution of matter, and its bearing on biological processes. He remarked that as the atomic and molecular theory was utilised to furnish an explanation of that flux of chemical activity which is denominated bioplasm, so have speculations on ionic action been pressed into the same service, and with some promise, wholly hypothetical as they may be. Nerve action is simply electrical action, negative ions being released where nerve blends with muscle or where systems of concatenated neurons come into connection. Ion after ion is precipitated, and thus neural conduction takes place. This play of ions is excited or inhibited by the character of the fluids with which the protoplasm is bathed—by the nature, that is, of the ions which these fluids contain. Most effective in stimulating protoplasmic action are such substances as sodium salts, as those of lime restrain it, and since such inorganic bodies are among the products of tissue waste, it may be that in the ions of metabolism are to be found the causes of that rhythmic tendency to activity which nerve cell and muscle fibre alike exhibit. If normal neuro-muscular action may be thus induced, the theory offers a clue to the comprehension of some of the most obscure morbid manifestations of these tissues. In many departments of physiology, notably in that concerned with nerve and muscle and with secretion, a large mass of information has been acquired as the result of experiments, whilst but little has been done towards ascertaining the ultimate structure of the tissues concerned —little, that is, beyond what was known a score of years ago or more. In respect to such tissues as these, microscopic examination would seem almost to have reached its limits; and for the complete comprehension of the physico-

chemical phenomena, more recently ascertained, the problem of the chemical and electrical constitution of the muscle or nerve fibre and of the gland cell awaits solution.

A REPORT on the photogrammetric measurement of the height of clouds at Simla during the twenty months June, 1900, to January, 1902, by Mr. W. L. Dallas, is published in the *Indian Meteorological Memoirs*, vol. xv. part ii. Only forty-seven good observations were secured, as it frequently happens that the lower clouds are ordinarily thick and below the level of the observatory (7224 feet). These observations give the mean height of cirrus 30,440 feet above Simla, and the maximum height 38,440 feet; of cumulus the mean and maximum heights are 7304 feet and 14,318 feet respectively.

WE have received from Mr. W. G. Davis a work on the climate of the Argentine Republic, compiled from observations made to the end of the year 1900. All the meteorological elements have been submitted to a careful and elaborate discussion, and the work is a most valuable contribution to the climatology of the South American Continent. In a general outline of the treatise, Mr. Davis points out that, in a country which embraces 33° of latitude, and the surface of which slopes from the Atlantic to the snow-clad Andes, great differences must prevail in the atmospheric conditions. In the narrow zone lying to the north of the Tropic of Capricorn, the mean annual temperature varies from 23° C. on the coast to less than 14° at the western limits, while the rainfall decreases from 1600 mm. to less than 50 mm. At 8° or 9° farther south, we find, in the Pampas, a mean temperature of 19°, which rapidly decreases towards the slopes of the Cordilleras; in the eastern part of Entre Rios the rainfall is 1000 to 1200 mm., and diminishes to less than 100 mm. in the province of San Juan. At 10° further south there is little difference in the isotherms (13° or 14°) between the Atlantic and the Andes, while the rainfall (200 to 400 mm.) is practically the same. At the extreme south of the Republic the climate is rigorous; in Tierra del Fuego the summer mean temperature is 8° to 9°, and the winter 2° to 3°. Rains are frequent, and no month is free from snow. At Staten Island the mean annual precipitation is 1400 mm., while in Tierra del Fuego less than half this quantity falls.

MR. R. W. PAUL has sent us his new catalogue of electrical testing instruments. The list, in addition to the usual resistance boxes, bridges, galvanometers, and other familiar testing instruments, includes several new pieces of apparatus and new patterns. Amongst these may be noticed the new pattern of Kelvin double bridge for the measurement of low resistances; there is also a new model Ayrton-Mather narrow-coil galvanometer having conveniently interchangeable coils. A new set of standard wattmeters, designed by Messrs. Duddell and Mather, is included in the list; these are constructed as much as possible from insulating materials, and range from 0·01 watt to 200 kilowatts. We hope to have an opportunity of describing them more in detail later. An interesting type of resistance has been designed for use with these wattmeters; it is made of silk-covered manganin wire, which is woven into a fabric with silk threads, thus giving a high resistance free from errors due to capacity or self-induction.

WE have received from Mr. C. E. Kelway a description of his system for warning ships at sea of approaching danger by equipping lighthouses with Hertzian signalling apparatus. The ships themselves would be fitted with a receiving apparatus which would respond when they came within the range of the wireless signals sent out from the lighthouse; these are to be sent out at regular intervals at the same times as the sound warnings. A ship, by observing the time that passes between receiving the wireless signal and the sound warning, is enabled at once to calculate its distance from the lighthouse; if it now continues on its course for a few miles and then makes a second observation, all the necessary data for ascertaining, trigonometrically, the exact position of the lighthouse are obtained. A special stop-watch reading directly in distances and a special position finder have been devised by Mr. Kelway for use with his system. The system was, we understand, submitted to the consideration of the recent Berlin Wireless Telegraphy Conference; it illustrates one of the many ways in which wireless telegraphy may be made of service to ships.

FROM the *Bulletin* of the Cracow Academy we have received reprints of several papers by Profs. Ladislaus Natanson and St. Zaremba dealing with certain points in the dynamical theory of viscosity.

MESSRS. TEUBNER, of Leipzig, announce the forthcoming publication of a new work entitled "Encyklopädie der Elementar-Mathematik," under the joint authorship of Profs. H. Weber (Strassburg) and J. Wellstein (Giessen). It is specially written for teachers, and will consist of three volumes dealing respectively with elementary algebra and analysis, elementary geometry, and applications of elementary mathematics.

THE *Proceedings* of the Edinburgh Mathematical Society for 1902–3 contain the reprint of some correspondence between Robert Simson (1687–1768, professor of mathematics at Glasgow, 1711–1761), Matthew Stewart (1717–1785, professor of mathematics at Edinburgh 1747–1772), and James Stirling, F.R.S. (1692–1770, author of works on Newton's cubic curves and on the calculus). The correspondence in question was bought at the Gibson Craig sale of manuscripts by Mr. J. S. Mackay in 1887.

THE *Bulletin* of the American Mathematical Society for October contains an English translation of Poincaré's review of Hilbert's "Foundations of Geometry." Hilbert's monograph is undoubtedly a classic, and Poincaré's comments upon it, as might be expected, are full of interest. One passage may be quoted as dealing with a misunderstanding which is too common. "Some people have gone so far as to . . . ask whether real space is plane, as Euclid assumed, or whether it may not present a slight *curvature*. They even supposed that experiment could give them an answer to this question. Needless to add that this was a total misconception of the nature of geometry, which is not an experimental science."

IN the *American Naturalist* for August, Dr. E. W. Doran emphasises the importance of the use of vernacular names for animals, and urges that, when these are of a composite nature, a uniform method in regard to the use of hyphens should be adopted in zoological literature. The rules he proposes with a view of attaining this desirable end will, we think, meet with the general approval of English writers.

MR. C. R. EASTMAN, on morphological grounds, expresses, in the *American Naturalist*, his disbelief in Dr. Patten's assertion that Cephalaspis was provided with a fringe of jointed and movable appendages along the ventral margin of the trunk. No such appendages exist in the allied Pterichthys, and it seems incredible that a vertebrate can possess more than two pairs of limbs. In these respects the writer has the support of Dr. Gaskell.

AT the conclusion of a paper on reptiles and amphibians from Arkansas and Texas, published in the *Proceedings* of the Philadelphia Academy for August, Mr. W. Stone discusses their bearing on previous views as to the zoogeographical zones of this part of the United States. He concludes that the boundary between the Austro-riparian and Sonoran areas, so far as reptiles are concerned, lies between the 96th and 98th meridians of longitude, that the Texan district of Prof. Cope should be referred to the Austro-riparian instead of to the Sonoran province, and that transcontinental zones of distribution are not indicated by reptilian evidence. The marked faunal division between the 96th and 98th meridians is due to this line marking the limits of the heavy rainfall of the Gulf coast.

A CURIOUS problem is presented by the hermit-crab. As is well known, these crustaceans present a marked asymmetry, which nearly always takes the form of a dextral spiral—in correlation with the circumstance that they generally inhabit dextral molluscan shells. Is, then, this asymmetry due to this habit, or was it pre-existent? In discussing this question in a paper on the metamorphoses of the hermit-crab, published in the *Proceedings* of the Boston (U.S.) Natural History Society, Mr. M. T. Thompson concludes that it cannot at present be definitely answered, owing to our imperfect knowledge of the relationships of the different generic representatives of the group. Nevertheless, the asymmetry is structurally adapted to the conditions imposed by the mode of life in question, and the presumption is accordingly very strong that it was from the first the result of a sojourn in dextrally spiral shells.

MR. M. J. NICOLL, who in 1902–3 accompanied the Earl of Crawford in his yacht, the *Valhalla*, round the world as naturalist, and made good collections in several branches of natural history, will again join the *Valhalla*, in the same capacity, next month for a winter tour in the West Indies. Mr. Nicoll's specimens collected during the last voyage are being examined and arranged at the British Museum, to which Lord Crawford has presented them. Mr. Nicoll's ornithological notes made during the voyage will be published in the next number of the *Ibis*.

IT has always seemed strange that so large and strongly marked an animal as the okapi (*Okapia johnstoni*) should have remained unknown to Europeans until its recent discovery on the Semliki by Sir Harry Johnston. But it would now appear, as is suggested by Herr Hesse, that a prior well-known African traveller, Wilhelm Junker, had obtained an imperfect skin of this animal at Zemio, in the Welle-basin, twenty years ago, although he did not recognise the nature of it, and was inclined to refer it to the water-chevrotain (*Hyomoschus aquaticus*). But as the animal was called by the natives "makapi," and was "of the size of a dwarf antelope," it seems more probable that the skin in question was that of a young okapi (see *Journ.* R.G.S., vol. xxii. p. 459).

IN the October number of *Climate* Dr. Louis Sambon continues his series of articles on the chief disease scourges of the tropics, dealing with malaria, yellow fever, cholera, plague and sleeping sickness. Another article of interest discusses the results obtained by the campaign against mosquitoes in various parts of the world.

THE Corporation of London has approved and adopted a series of regulations drafted by its Public Health Department for the sanitary control of the milk supply of the City. Some of these deal with the registration of the premises and their sanitary condition, contamination of milk, milk from diseased cows, &c. Others seek to secure the cleanliness of milk-shops and vessels, and the safeguarding of the milk-supply against infection from without.

THE health of the great armies of Europe is discussed by Dr. V. Lowenthal in an interesting statistical article in the *Revue générale des Sciences* (September 30). Of the armies of the six great Powers, France, Germany, Austria, Russia, Italy, and England, France heads the list both in the total mortality rate and in the attack rate. On the whole the German Army is the most healthy, then comes the Italian, and then the British. But for the enormous incidence of venereal affections, the latter, however, would in all probability appear as the most healthy.

"THE GEOLOGY OF THE COUNTRY AROUND TORQUAY" is the title of a memoir by Mr. W. A. E. Ussher that has just been issued by the Geological Survey. The author has for many years been engaged in a detailed examination of the Devonian rocks, and he gives full particulars of the complex structure of the area and of the several subdivisions of the strata, with lists of fossils. Useful tables are given showing the Continental equivalents. The terra-cotta clays of Watcombe, and the red sandstones and conglomerates that form portions of the picturesque cliffs, are grouped as Permian. Cavern-deposits, Raised Beaches, and other superficial deposits are described, and there is a short chapter on economics.

MESSRS. DAWBARN AND WARD, LTD., are publishing a series of penny pamphlets dealing with various subjects of interest to practical photographers. The first number in the series discusses the prevention and cure of halation, and the fourth number the camera and its movements.

THE ninth annual volume—that for the present year—of the *Reliquary and Illustrated Archaeologist* has been issued by Messrs. Bemrose and Sons, Ltd. The volume contains the four quarterly issues of the magazine which have been published this year, and most of the articles are excellently and profusely illustrated. The publication appeals preeminently to antiquarians, ethnologists and archæologists.

MR. JOHN MURRAY has published a cheap edition—five shillings net—of Nasmyth and Carpenter's classical work on "The Moon." The original work was published thirty years ago, and was reviewed in these columns on March 12, 1874 (vol. ix. p. 358). Three editions of the book were issued, but they have been out of print for several years, and the publication of the work in a popular and compact form will be welcomed by many students of astronomy.

A FIFTH edition of the "Manual of Pathology" by the late Prof. Joseph Coats has been published by Messrs. Longmans, Green and Co. The new edition has been revised throughout by Prof. L. R. Sutherland, and considerable alterations have been made without interfering materially with the original plan of the book. The chapter on bacteriology has been omitted, and the illustrations have been increased in number from 490 to 729. Two new coloured plates have also been added.

THE fourth revised edition of Prof. Max Verworn's "Allgemeine Physiologie" has been published by Mr. Gustav Fischer, Jena. The first edition of this well-known work was reviewed in NATURE in 1895 (vol. li. p. 529). A translation of the second edition, by Dr. F. S. Lee, was published in 1899, and was also noticed at length in these columns (vol. lx. p. 565). Since the third German edition was published in 1901, progress has been made in the

knowledge of the physiology of the cell, and the sections devoted to this subject have been carefully revised for the new edition now available.

WITH the advance of scientific education in this country scientific instrument makers are continuously bringing out improved forms of apparatus. We have recently received from Messrs. Brewster, Smith and Co. an improved form of a "double surface condenser." This is one of the most compact and efficient condensers which has come before our notice. We have tested it for condensing such volatile substances as ether, carbon disulphide, and acetone, and have found that even with rapid distillation the condensation is very complete. Generally speaking, in order to condense these substances satisfactorily, it is necessary to employ a very long condenser; of course, this means using a great amount of bench space. As the new condensers are used in a perpendicular position, the saving in space is very great.

MESSRS. BREWSTER, SMITH AND CO. have also sent us a "new Bunsen burner and midget furnace." It can hardly be said that the Bunsen burner is new, but the combination of furnace and burner is very convenient. The makers claim that marble is reduced to quicklime in ten minutes. This will, of course, to a large extent depend upon the quantity of marble taken in the first place—we find that from one to one and a half grms. is readily reduced to quicklime in twenty minutes. These little furnaces are not only useful for reducing calcium carbonate to lime, but also work very well in fusion experiments.

THE measurements by Biltz and Preuner of the density under different pressures of sulphur-vapour at 448° have usually been regarded as indicating that the vapour is composed of S_8 and S_2 molecules, and that the molecule S_6 does not exist. The application to the isothermal of the law of mass-action, discussed by Preuner in the *Zeitschrift fur physikalische Chemie*, shows that this theory is inadequate, and that the vapour must contain molecules intermediate in complexity between S_8 and S_2. The proportions by volume of the constituents are calculated to be, under 104 mm. pressure, 29.2 per cent. S_8, 19.0 S_6, 19.7 S_4 and 32.1 S_2, and under 453.4 mm. pressure, 77.8 S_8, 15.1 S_6, 4.7 S_4 and 2.4 S_2.

SINCE Beckmann showed that iodine in all solvents has the molecular weight I_2, it has been suspected that the formation of violet or brown solutions is dependent upon the extent to which the iodine combines with the solvent. By means of comparative experiments on the solubility of iodine and the periodide $N(CH_3)_4I_9$, described in a recent number of the *Zeitschrift fur physikalische Chemie*, Strömholm has obtained evidence that iodine actually combines with water, alcohol and ether, forming brown solutions, whilst the violet solutions in carbon disulphide, benzene and chloroform contain uncombined iodine; similarly it is shown that iodine has little tendency to combine with methyl iodide when dissolved in ether, or with sulphur dissolved in carbon disulphide.

THE additions to the Zoological Society's Gardens during the past week include a Black Lemur and young (*Lemur macaco*) from Madagascar, a Brazilian Hare (*Lepus brasiliensis*) from Brazil, eight Hamsters (*Cricetus frumentarius*), a Snow Bunting (*Plectrophenax nivalis*), four Lacertine Snakes (*Coelopeltis monspessulana*), two Dark-green Snakes (*Zamenis gemonensis*), a Vivacious Snake (*Tarbophis fallax*), European; three Cuban Snakes (*Liocephalus andreae*) from Cuba, two Garter Snakes (*Tropidonotus ordinatus*), a Prickly Trionyx (*Trionyx spinifer*) from North America, a South Albemarle Tortoise (*Testudo vicina*) from Galapagos, a Wrinkled Terrapin (*Chrysemys scripta rugosa*) from the West Indies, two Amboina Box Tortoises (*Cyclemys amboinensis*) from the East Indies, two Annulated Terrapins (*Nicoria annulata*) from Western South America, a Horned Lizard (*Phrynosoma cornutum*) from Mexico, a Carinated Lizard (*Liocephalus carinatus*) from the West Indies, two Hispid Lizards (*Agama hispida*) from South Africa, two Scoresby's Gulls (*Leucophoeus scorebii*) from Chili, deposited; a Tasmanian Devil (*Sarcophilus ursinus*) from Tasmania, received in exchange.

OUR ASTRONOMICAL COLUMN.

SEARCH-EPHEMERIS FOR COMET 1896 V.—A further portion of the search-ephemeris for Giacobini's comet (1896 v.), published by Herr M. Ebell in No. 3898 of the *Astronomische Nachrichten*, is given below. As will be seen from this ephemeris the computed brightness is now decreasing, although the comet should be in a favourable position for observers in the northern hemisphere:—

12*h*. *M.T. Berlin*.

1903	α h. m. s.	δ ° ′	log *r*	log Δ	Brightness.
Oct. 28	3 54 51	+ 8 6·5	0·2943	0·0130	2·21
Nov. 1	3 51 18	+ 7 23 8			
„ 5	3 47 33	+ 6 43·7	0·3055	0·0242	1·99
„ 9	3 43 40	+ 6 7·0			
„ 13	3 39 46	+ 5 34·0	0·3165	0·0410	1·75
„ 17	3 35 56	+ 5 5·3			
„ 21	3 32 15	+ 4 40·9	0·3274	0·0633	1·51
„ 25	3 28 50	+ 4 21·2			
„ 29	3 25 44	+ 4 6·0	0·3381	0·0901	1·27

A NOVEL FEATURE FOR GEODETICAL INSTRUMENTS.—In a paper contributed to No. 26, vol. iii., of the *British Optical Journal*, Sir Howard Grubb describes a novel feature in geodetical instruments which replaces the half-silvered, half-plain piece of glass generally used in such instruments by a piece of glass having a thin film of lead sulphide deposited on its surface. This film both reflects and transmits the incident light, and by varying its thickness the proportion of transmitted to reflected light may be varied.

Taking the case of the prismatic compass as an illustration, the rays of light from the object the position of which is to be determined are transmitted by the film of lead sulphide, and, at the same time, the previously collimated rays from the compass card are reflected by it. As both sets of rays are parallel, and the reflection of the card is superimposed on the image of the distant object, parallax does not interfere in the observations, and the position of the eye may therefore be changed without introducing any error into the reading, thereby rendering it possible to make the readings much more quickly and accurately than when using the older forms of reflecting-transmitting apparatus.

THE PATH OF COMET 1894 I. (DENNING).—No. 2 of the *Mitteilungen* of the Heidelberg Observatory contains a paper by Dr. P. Gast on the observations and calculations of the path of comet 1894 I.

The first part is devoted to a series of new observations of the comparison stars made during the year 1902, and is followed by a collection of the observations of the comet which were made at various observatories, then the various observations are compared among themselves and with the computed elements of this comet. The paper concludes with a discussion of the perturbations produced by Jupiter and the finally deduced elements. In a supplementary list the positions of eighty-eight reference stars for the year 1900 are given, the value of the precessional constant, the secular variation, and the star's proper motion being stated in each case.

OBSERVATIONS OF MARS.—In the October number of the *Bulletin* de la Société astronomique de France, MM. Flammarion and Benoit publish the results of their observations of Mars made at Juvisy during the last opposition of that planet. Although the planet was nearer to the earth during this opposition than it was in 1901, the unfavourable meteorological conditions prevented the making

of a complete record, but the set of fourteen drawings of the polar cap which accompany the paper show very clearly the diminution of the cap from October 15, 1902, to March 15, 1903, and its augmentation from then until July 1, the minimum apparently taking place at an earlier date than usual.

In addition to detailed descriptions of the most interesting observations, the paper contains reproductions of ten excellent drawings showing various features on the planet's surface.

NATAL GOVERNMENT OBSERVATORY.—The report of the Government Astronomer for Natal, Mr. E. Nevill, for 1902 is chiefly devoted to the various meteorological records of the colony, and forms a valuable addition to the meteorology of last year.

After giving brief descriptions of the staff, the instruments, the management of the time signals, the magnetic observations, and the tide records, the report gives a number of tables containing very complete records of the meteorological results obtained at the Durban Observatory and twenty-two inland stations, and the less complete records of twenty-six subsidiary stations which are scattered throughout the colony.

In dealing with this section of the report Mr. Nevill directs special attention to the importance of obtaining the fullest possible records of the meteorological conditions in Natal, because, in addition to their local importance, it has been shown that there is a very close connection between them and the conditions obtaining in Australia and India. In the latter case there are trustworthy indications that the meteorological conditions of Natal are those which are likely to prevail in India during the following season; this is especially marked in the case of the rainfall.

INHERITANCE OF PSYCHICAL AND PHYSICAL CHARACTERS IN MAN.[1]

THERE are probably few persons who would now deny the immense importance of ancestry in the case of any domestic animal. A majority of the community would probably admit also that the physical characters in man are inherited with practically the same intensity as the like characters in cattle and horses.

But the preeminence of man in the animal kingdom is justly attributed, not to his physical, but to his psychical character. The latter is seen developing apparently under the influences of home and of school, and we conclude, perhaps too rashly, that home and school are the chief sources of the psychical qualities. We are too apt to overlook the possibility that the home standard is itself a product of stock, and that the relative gain from education depends in a surprising degree on the raw material presented to the educator.

It is possible to hold this view and yet believe that moral and mental characters are inherited in either a qualitatively or a quantitatively different manner from the physical characters. Both may be influenced by environment, but one in a far more marked way than the other.

Some six or seven years ago, then, I set myself the following problem: What is the quantitative measure of the inheritance of the moral and mental characters in man, and how is it related to the corresponding measure of the inheritance of the physical characters?

The problem really resolved itself into three separate investigations:—

(a) A sufficiently wide inquiry into the actual values of inheritance of the physical characters in man.

For this investigation upwards of 1000 families were measured, giving ample means of determining the quantitative measure of resemblance for both parental and fraternal relationships.

(b) A comparison of the inheritance of the physical characters in man with those in other forms of life.

No substantial difference in this inheritance has been discovered.

(c) An inquiry into the inheritance of moral and mental characters in man.

Owing to the great difficulty of comparing the moral characters of a child with those of its adult parents, I confined my attention to *fraternal* resemblance, for if fraternal resemblance for moral and mental characters is less than, equal to, or greater than its value for physical characters, the same must be true for parental inheritance.

In the next place it seemed impossible to obtain moderately impartial estimates of the psychical characters of *adults*. The inquiry, therefore, was limited to *children*, so that the partial parent or relative could be replaced by the fairly impartial school teacher.

After much consideration and some experimenting, schedules were prepared in which teachers could briefly note the chief characteristics of the children under their charge. These schedules were white for a pair of brothers, pink for a pair of sisters, and blue for a brother and sister. With the schedules specially devised headspanners were distributed, directions for the use of the headspanner, and general directions as to the estimation of the physical and mental characters.

The material took upwards of five years to collect. Appeal was made through the columns of the educational journals to teachers of all kinds, and the observations were made not only in the great boys' public schools and the grammar schools of the country, but in modern mixed schools, in national and elementary schools of all kinds, in board schools, and private schools throughout the kingdom. Some 6000 schedules were distributed, and between 3000 and 4000 returned with more or less ample data. I have most heartily to thank the masters and mistresses of some 200 schools in which observations have been made for me. In the midst of arduous professional claims on their time and energy, they have, in many cases at considerable personal inconvenience, recorded and measured the children in their charge for a purpose only dimly foreshadowed for them.

Much of what I have to say upon the nature of the theory applied will not be new to those who have examined recent biometric work, and some of it will not be intelligible except to the trained mathematician. Still we must strive in broad lines to see how the work has been done, and, above all, to justify our treatment of the psychical character.

[To illustrate the method the lecturer examined the degree of resemblance between the cephalic indices of brothers, the cephalic index of a person being 100 × the ratio of breadth to length of head. This scarcely changes with growth after the first two years of life. A table was exhibited showing the cephalic index for 1982 pairs of brothers.]

Taking the boys, for example, with cephalic indices between 74 and 75, these boys had seventy-eight brothers who were distributed according to the column headed 74 to 75. Brothers are not alike in cephalic index, but distributed with a considerable range of variation. The arithmetic mean of the cephalic indices of this array of brothers is 77·45. Thus the average brother of a boy with cephalic index 74·5 has a cephalic index =77·45. This is the phenomenon of regression towards the general population mean (78·9) discovered by Francis Galton.

We now find by taking all the arrays that whatever the cephalic index of first brother be, cephalic index of mean second brother

$$= (1-\alpha)\{\text{mean cephalic index of whole population}\} + \alpha\,\{\text{cephalic index of first brother}\}$$

and that in the case of cephalic indices for two brothers the quantity α, defined as the "resemblance," has the value 0·5.

Now from this result we have learnt two great features about inheritance in man. Firstly, that part of the cephalic index of the second brother depends in the above linear manner on that of the mean of the whole population and part on that of the first brother; and, secondly, that these parts are about equal. Are these true for other characters than the cephalic index? Undoubtedly, for all physical characters. And further, the fraction α, which we have called the resemblance, is, for brethren, in all cases about 0·5.

This surprising uniformity in the inheritance of the measurable physical characters can be extended to physical characters not capable of accurate measurement, and to psychical characters provided we assume a certain distribution of frequency for such characters in human popu-

[1] Abstract of the Huxley Memorial Lecture for 1903. Delivered before the Anthropological Institute on October 16, by Prof. Karl Pearson, F.R.S.

lations. Suppose, then, we assume that the moral and mental qualities in man, like the physical, follow a normal law of distribution. What results shall we obtain by thus assuming perfect continuity between the physical and psychical? I cannot free myself from the conception that underlying every psychical state there is a physical state. Hence I put to myself the problem as follows:—

Assume the fundamental laws of distribution which we know hold for the physical characters in man, and see whither they lead us when applied to the psychical characters. They must (*a*) give us totally discordant results. If so, we shall conclude that they have no application to the mental and moral attributes. Or (*b*) they must give us accordant results. If so, we may go a stage further, and ask how these results compare with those for the inheritance of the physical characters; are they more or less or equally subject to the influence of environment? Here are the questions before us. Let us examine how they are to be answered. Taking as an example *ability in girls*, we find that the resemblance between sisters is 0.47. There can, I think, be no doubt that *intelligence* or *ability* follows precisely the same laws of inheritance as cephalic index or any other physical character.

I ask you to admit that I came to this inquiry without prejudice. I expected *a priori* to find that the home environment largely affected the resemblance in moral qualities of brothers and sisters. Putting any thought of prejudice on one side, accept for a moment the methods adopted, and look at the broad results of the inquiry. You have in the first table the mean resemblance of the physical characters of brothers and sisters from my records of family measurements. You have in the second table the mean of the physical measurements of our school records. These two series absolutely confirm each other, and give a mean resemblance of 0.5 nearly between children of the same parents for all physical characters. How much of that physical resemblance is due to home environment? You might at once assert that size of head and size of body are influenced by food and exercise. It is quite true. But can any possible home influence affect cephalic index or eye colour? I fancy not; and yet these characters are within broad lines inherited exactly like the qualities directly capable of being influenced by nurture and exercise. I am compelled to conclude that the environment influence on physical characters is to the first approximation not a great disturbing factor when we consider degrees of fraternal resemblance in man.

Now turn to the list of the degrees of resemblance in the mental and moral characters. We find, perhaps, slightly more irregularity than in the case of the physical characters. The judgment required is much finer, the classification much rougher, but the obvious conclusion is still that the values of the coefficient a giving the resemblance again cluster round 0.5.

We are forced, I think literally forced, to the general conclusion that the physical and psychical characters in man are inherited within broad lines in the same manner and with the same intensity.

This *sameness* surely involves something additional. *It involves a like heritage from parents.* So we inherit our parents' tempers, our parents' conscientiousness, shyness and ability, even as we inherit their stature, forearm and span.

At what rate is that? [A table was shown which represents our present knowledge of parental inheritance in man and in the lower forms of life, the resemblance of parent and offspring being again roughly 0.5.] So the psychical characters are not features which differentiate man from the lower types of life.

If the conclusion we have reached to-night be substantially a true one, and for my part I cannot for a moment doubt that it is so, then what is its lesson for us as a community? Why, simply that geniality and probity and ability, though they may be fostered by home environment and good schools, are nevertheless bred and not created. The education is of small value unless it be applied to an intelligent race of men.

Our traders tell us we are no match for the Germans or Americans. Our politicians catch the general apprehension and rush to heroic remedies. Looking round impassionately from the calm atmosphere of anthropology, I fear there really does exist a lack of leaders of the highest intelligence, in science, in the arts, in trade, even in politics. I do seem to see a want of intelligence in the British professional man and in the British workman. But I do not think the remedy lies in adopting foreign methods of instruction or in the spread of technical education. I believe we have a paucity just now of the better intelligences to guide us, and of the moderate intelligences to be guided. The only account we can give of this on the basis of the result we have reached to-night is that we are ceasing as a nation to breed intelligence as we did fifty to a hundred years ago. The only remedy, if one be possible at all, is to alter the relative fertility of the good and bad stocks in the community. We stand, I venture to think, at the commencement of an epoch which will be marked by a great dearth of ability. We have failed to realise that the psychical characters which are in the modern struggle of nations the backbone of a State are not manufactured by home and school and college; they are bred in the bone; and for the last forty years the intellectual classes of the nation, enervated by wealth or by love of pleasure, or following an erroneous standard of life, have ceased to give us the men we want to carry on the ever-growing work of our Empire, to battle in the fore rank of the ever-intensified struggle of nations.

The remedy lies in first getting the intellectual section of our nation to realise that intelligence can be aided and be trained, but no training or education can create it. You must breed it; that is the broad result for statecraft which flows from the equality in inheritance of the psychical and the physical characters.

THE APPLICATION OF LOW TEMPERATURES TO THE STUDY OF BIOLOGICAL PROBLEMS.[1]

THE cellular doctrine lies at the basis of modern biological research. Living matter in its simple and complex conditions consists essentially of protoplasm with a contained body or nucleus. The two elements plasma and nucleus constitute the elementary organism—the cell. The lowest individual forms of life are represented by a single cell, and such unicellular organisms may be either of a vegetable or animal type. The cells in each instance exist as free living and independent organisms. The higher forms of life are built up of parts in which the structural unit remains the cell, despite the modifications the cell necessarily undergoes as a fixed element in the various tissues and organs. All phases of animal and plant life are demonstrably of cellular origin and organisation, and their vital manifestations represent the summed up activities of cells. Every vital problem, therefore, is ultimately a cellular problem, and a direct study of the cell, in so far as may be possible, is the keynote of biological research. The methods to be adopted will depend upon the problem it is desired to investigate. A histological technique, aided by the microscope, will naturally be employed where it is desired to study the relations of parts and the structural organisation of the tissues and their cellular elements. The soluble products of the living cell spontaneously present themselves for examination by chemical and other means. It is otherwise with regard to the agencies acting and the processes occurring within the confines of the cell. These are naturally beyond the range of the ordinary methods of observation. The essential processes of life are intracellular and intimately bound up with the living substance of the cell, and of these but few data are possessed. The importance of the problems involved is as great as their investigation is difficult. The cell exercises its vital functions in virtue of a specific physical and chemical organisation of its molecular constituents. The ordinary methods of biological and chemical research modify or destroy this organisation, and do not admit of an intimate study of the normal cell constituents. For this purpose it is essential to eliminate or to reduce to a minimum the influence of external modifying agents on the cell or its immediate products. An intracellular physiology can only be based on a direct study of intracellular constituents apart from their secretions and products. This, in ordinary circumstances, is impossible with

[1] By Dr. Allan Macfadyen. Communicated to Section B of the British Association at Southport, by Prof. J. Dewar, F.R.S.

respect to actively functionating and intact cells. It is obvious, therefore, that the first desideratum is a suitable method of obtaining the cell plasma for experimental purposes, and it is only recently that this has been successfully accomplished. The most feasible means of procedure appeared to be the use of *mechanical* agents which, whilst bringing the cell substance within the field of observation, would, at the same time, be least likely to affect its character and constitution. The method consists in a mechanical rupture of the cells and the release of their contents under conditions favouring the conservation of their properties. The first successful application of this description of method was made by Buchner in the particular instance of the yeast cell, and with brilliant results. The researches of Buchner were of wide biological significance, and were suggestive of much more than a cell-free alcoholic fermentation of sugars. They demonstrated the possibilities of the new methods with regard to more general vital problems. The Buchner process consisted in a mechanical trituration of the yeast cell with the aid of sand and a subsequent filtration of the resultant mass under pressure through Kieselguhr. The filtrate contained the expressed constituents of the yeast cell which were capable of passing through Kieselguhr, and the product, in virtue of its fermentative properties, was termed "zymase."

The author and his colleagues have, during the past four years, been engaged in investigating the application of cognate methods to biological research. The advice and help generously afforded by Prof. James Dewar materially forwarded the progress of the research.

It was considered that, by the employment of low temperatures, a disintegration of living cells might possibly be accomplished, and a wide field of inquiry opened to investigation in the biological laboratory. For this purpose the methods of mechanical trituration required refinement in several directions.

The conditions it was desired to fulfil were, a rapid disintegration of the fresh tissues and cells, an avoidance of heat and other modifying agents during the process, and an immediate manipulation of the cellular juices obtained.

It had likewise been noted that ordinary filter pressing through Kieselguhr removed physiologically active substances from the cell juices. Liquid air appeared to be the most convenient means of obtaining the necessary cold, and it presented the advantage of a fluid freezing medium in which the material to be manipulated could be directly immersed. The temperature of this reagent (about $-190°$ C.) would, in addition, prevent heat and chemical changes, whilst reducing the cells to a condition of brittleness favourable to their trituration without the addition of such substances as sand and Kieselguhr, which might modify the composition of the resultant product.

The method, if successful, would meet the conditions desired for the subsequent study of the intracellular juices. It may be briefly and generally stated that, by the application of low temperatures, a mechanical trituration of every variety of cell *per se* has been accomplished, and the fresh cell plasma obtained for the purpose of experiment. A number of control experiments have demonstrated that immersion in liquid air is not necessarily injurious to life—bacteria, for example, having survived a continuous exposure for six months to its influence. The actual trituration of the material is accomplished in a specially devised apparatus, which is kept immersed during the operation in liquid air.

The normal and diseased animal tissues have been treated in this manner, and their intracellular constituents obtained, *e.g.* epithelium, cancer tissues, &c.

Moulds, yeasts and bacteria have been rapidly triturated under the same conditions, and the respective cell juices submitted to examination.

The severest test of the capabilities of the method was furnished by the bacteria, an order of cells for which the standard of measurement is the *mikron*. The experiments proved successful in every instance tested. The typhoid bacillus, for example, is triturated in the short space of two to three hours, and the demonstration has been furnished that the typhoid organism contains within itself a toxin. From these and other researches it has become evident that there exists a distinct class of toxins and ferments which are contained and operate within the cell or bacterium, in contradistinction to the now well-known class of toxins which are extracellular, *i.e.* extruded during life from the cell into the surrounding medium. To this latter class belongs the diphtheria toxin, which has been so successfully used in the preparation of diphtheria antitoxin. A number of infective organisms do not produce appreciable extracellular toxins, and the search must therefore be made within the specific cells for the missing toxins to which the intoxication of the body in the course of the disease in question is probably due. The practical utility of investigating these intracellular toxins has already become evident in the preparation from the intracellular toxin of the typhoid bacillus of a serum having antitoxic value as regards this toxin.

The experiments made with the pus organisms have already shown that intracellular toxins exist in this important order of disease germs.

The cell juices of other types of pathogenic bacteria, such as the tubercle and diphtheria bacillus, present characteristics of equal interest.

The application of low temperatures has aided the investigation of certain other biological problems.

The photogenic bacteria preserve their normal luminous properties after exposure to the temperature of liquid air. The effect, however, of a trituration at the same temperature is to abolish the luminosity of the cells in question. This points to the luminosity being essentially a function of the living cell, and dependent for its production on the intact organisation of the cell.

The rabies virus has not yet been detected or isolated, although regarded as an organised entity. The seat of the unknown rabies virus is the nervous system. If the brain substance of a rabid animal be triturated for a given length of time at the temperature of liquid air, its infective properties as regards rabies are abolished. This result appears to be a further indication of the existence in rabies of an organised virus.

The method described admits of a fresh study of the question of immunity from an intracellular standpoint.

The intracellular juices of the white blood cells have been obtained, and tested with regard to bacteriolytic properties and the natural protection that may thus be afforded to the body against the invasions of microparasites.

The application of low temperatures to the study of biological problems has furnished a new and fruitful method of inquiry.

PHYSICS AT THE BRITISH ASSOCIATION.

THE meeting of the International Meteorological Committee at Southport during the week of the meeting of the Association resulted in an unusually large proportion of the papers presented to Section A dealing with cosmical problems, and these were taken in the department of the section devoted to astronomy and meteorology. Of the matters brought before the department devoted to physics, there seems little doubt that the most important were those involved in the discussions on the introduction of vectorial methods into physics, on the treatment of irreversible processes in thermodynamics, and on the nature of the emanations from radio-active substances respectively, and of these a short account follows.

In opening the discussion on the introduction of vectorial methods into physics, Prof. Henrici pointed out that, although vectors were invented for use in dynamics, the ideas involved were fully introduced into physics by Faraday's representation of the stresses in a medium by lines of force. Maxwell was aware of this, and devoted some sections of the opening chapter of his "Electricity and Magnetism" to an exposition of the properties of vectors, and expressed many of his later equations in vectorial form.

So long as we have to deal with quantities which involve magnitude and direction, but which are not specified as starting from a definite point, *i.e.* with non-localised vectors, a very simple algebra is all that is necessary, and when at any time it is required to extend our methods to localised vectors the methods of Grassmann's "Ausdehnungslehre" are available. The algebras which have been proposed for dealing with the simpler case agree in making addition follow the parallelogram law for compounding two forces, but they differ in the meanings they

attach to multiplication. In Prof. Henrici's algebra the products of two vectors α, β are:—$(\alpha\beta)$ a non-directional or "scalar," in magnitude equal to the product of one vector into the component of the other along the first, and $[\alpha\beta]$ a vector perpendicular to the plane drawn through α and β, and in magnitude equal to the area of the parallelogram of which α and β are concurrent sides. This algebra is evidently identical with those of Heaviside and Gibbs, and, like them, open to the objection that it does not discriminate between "polar" vectors, *e.g.* forces and "axial" vectors, *e.g.* couples. Its relation to that of quaternions is expressed by the equation $\alpha\beta = -(\alpha\beta)+[\alpha\beta]$, where $\alpha\beta$ is the quaternion product of α and β. If, now, u be a scalar function of the vector ρ of a point P, and P be displaced through a distance $d\rho$, the change du in the value of u will be proportional to $d\rho$, and may be denoted by $d\rho\,.\,\nabla u$, where ∇u is a vector such that for a given magnitude of $d\rho$, du is a maximum when $d\rho$ is parallel to ∇u. Hence the direction of ∇u is that of the greatest rate of change of u, and its magnitude that rate of change. Similarly for a vector function η of ρ $d_\rho\eta = (d\rho\nabla.)\eta$, and ∇ follows quite generally the laws of combination of vectors. Thus we have $(\nabla\eta)$ the "divergence" of η and $[\nabla\eta]$ the "curl" of η, with their numerous applications. By the use of this operator ∇, theorems like those of Green and Stokes can be proved in a generalised form with great ease and elegance, and the equations for the electromagnetic field follow in a couple of lines of work.

With so powerful a calculus as this at command, Prof. Henrici considers it the height of folly, after using vectorial methods in those elementary parts of physics which deal with addition of forces or velocities, to drop them for Cartesian coordinates and direction cosines at the next step forward. He advocates the use of vectors throughout, and, like Heaviside, would make trigonometry follow and depend on vectors by the definitions $x=r \cos \theta$, $y=r \sin \theta$. Vectors would thus be introduced into school curricula previous to or along with the use of squared paper and the idea of coordinates.

In the discussion which followed, Sir Oliver Lodge, Dr. Sumpner and others spoke as to the usefulness of vectorial methods in physical work. Prof. Larmor said there could be no doubt as to the extreme elegance of vectorial methods, and attributed the slow progress they had made to the want of uniformity in definitions and notation, which rendered it necessary for each writer who used vectors to describe his notation and methods before his work could be understood by his readers. Mr. Swinburne also referred to this difficulty. Prof. Boltzmann pointed out that this confusion would have been avoided if Hamilton had accepted Grassmann's methods and notation. The writer suggested that the question of the possibility of introducing greater uniformity into the notation and methods of vector algebra was a suitable one to be considered by a committee of the British Association. Prof. Henrici thought there would be little difficulty in coming to some agreement between the advocates of the various systems now in existence. His communication was ordered to be printed *in extenso* in the reports, so that those interested in the subject might be able to consider the suggestions made in detail.

Mr. Swinburne opened the discussion on the treatment of irreversible processes in thermodynamics by pointing out that so much attention was devoted in books on thermodynamics to the consideration of the changes involved in reversible processes, and so little to irreversible ones, that there was a danger of the latter being overlooked, although they are the only ones which really occur in nature. His object was to bring them more prominently forward, and to suggest a method of introducing the subject which would not involve alteration or extension of fundamental ideas on passing from reversible to irreversible changes. The sketch of the method he proposed was necessarily brief, and it was not easy at the time to see to what the proposals made would eventually lead. This probably accounts for the unsatisfactory nature of the discussion, which consisted to a great extent of statements by the speakers that they had been unable to understand what was proposed, or of condemnation of any attempt to alter the definition of entropy. Fortunately, copies of Mr. Swinburne's communication were available, and a quiet perusal of his suggestions shows that they are by no means so drastic as was supposed.

He points out that, while the first law of thermodynamics asserts that heat is a form of energy, the second states that only a portion of a given supply of heat is available for conversion into work, although energy of other forms is wholly convertible. That part of a supply of heat which cannot be converted into work during a cyclic change of state of the body containing the heat he proposes to call the "waste heat." It depends on the temperature of the coldest available reservoir of heat of large capacity, say that of the sea. Any process which goes on in an isolated system involves in general an increase of this "waste," and the quotient of this increase by the temperature of the coldest available reservoir of heat Mr. Swinburne defines as the increase of entropy of the system during the process.

A part of the system may decrease in entropy, but the rest must increase by at least an equal amount. If the increase is equal to the decrease the increase is said to be "compensated," if it exceeds the decrease the excess is the "uncompensated" increase of entropy. A reversible change in an isolated system involves no increase of entropy of the system, and any change in the entropy of any part of the system must therefore be "compensated." When irreversible changes occur there is an increase of entropy of the system, and an uncompensated increase of entropy of some part of it. So far as reversible changes are concerned, it is evident that Mr. Swinburne's definition of entropy leads to the same result as the one commonly used, *i.e.* $\int \frac{dH}{\theta} = d\phi$. For if in a Carnot cycle heat H_1 is taken in by the working substance at a temperature θ_1, the increase of entropy of the substance $=H_1/\theta_1$, and if at the temperature of the coldest available reservoir θ_0, H_0 is given up by the substance, H_0 is Mr. Swinburne's waste heat, and H_0/θ_0, according to his definition, the increase of entropy of the substance when it took in H_1 from the reservoir θ_1. As temperatures are measured on the absolute scale, the two quantities are identical.

From this point onwards Mr. Swinburne's treatment of the equilibrium of isolated systems is much like those in use at present, except that he objects to the use of some of the names, *e.g.* "thermodynamic potential," now commonly used.

Prof. Perry, in the discussion which followed, stated that engineers, while using the definition of entropy which connected it with reversible changes, were quite aware that most of the processes with which they had to deal were irreversible, and that their theory was an approximation only.

Prof. Larmor thought Mr. Swinburne's method was a praiseworthy attempt to introduce simplification and precision into a part of the subject which had received little attention, and was still somewhat obscure, and Mr. Boys added that the ideas brought forward were well worthy of careful consideration.

Before stating his views as to the nature of the emanations from radio-active substances, Prof. Rutherford gave a short *résumé* of the known facts about radio-activity. Substances which possess the property throw off material which carries with it a positive electric charge. This charged material can penetrate to some extent through solids, is deviated in electric and magnetic fields, and appears to consist of particles of matter of about twice the weight of a hydrogen atom, moving with a velocity about one-tenth that of light. This is known as the α radiation, and accounts for about 99 per cent. of the energy sent out by a radio-active substance. Another kind of radiation, known as the β or kathode ray, is also emitted. It is negatively charged, more penetrative and more easily deviated than the α radiation, and appears to consist of particles of about one-thousandth the mass of the hydrogen atom. A third kind of radiation, known as the γ, is more penetrative still, but up to the present has not been sufficiently studied to enable its properties to be definitely stated. The matter which remains after the α radiation has been thrown off behaves in the case of thorium and radium like a gas of large molecular weight, diffuses, condenses at low temperatures, may deposit itself on bodies with which it comes into contact, and may again divide into a posi-

tively charged α radiation and a second emanation, and so on until the changes cease to produce the usual effect on an electrometer. Whatever the nature of the radio-active material, the amount of radiation it emits in unit time is equal to λ times the amount of radio-active element present, where λ is a constant for each type of matter, and is unaffected by chemical and physical agencies.

Prof. Rutherford regards the process which goes on in radio-active substances as a gradual breaking up of the atoms of the substance, and this gradual disintegration as the cause of the radio-active properties. The electrically neutral atom of a radio-active substance throws off a positively charged body which constitutes the α radiation; what remains of the atom constitutes the emanation. This again throws off a positively charged body, and the process repeats itself until the positively charged bodies are exhausted, and the substance no longer possesses radio-active properties.

This disintegration theory fits all the known facts, but it involves the existence in the atom of a radio-active substance of a store of energy hitherto unsuspected, amounting in the case of radium to at least 10^{16} ergs per gram. This energy exists, according to Prof. Rutherford, as kinetic energy of motion of the atoms in closed paths with velocities comparable with that of light, and disintegration is the moving off at a tangent of one or more of the particles of an atom. If this is the case it seems probable that the atomic energy of elements not yet found to be non-radio-active is of the same order of magnitude, and may be set free by methods of which we are not yet cognisant.

In the discussion which followed Sir Oliver Lodge said the theory put forward by Rutherford seemed to him to be a valuable working hypothesis, very near, if not absolutely, the truth. It was supported by Larmor's electrical theory, according to which the atoms of matter should be unstable.

Lord Kelvin, in a letter communicated to the section, put forward another theory as to the nature of the processes going on in radio-active materials. According to it each atom of matter has positive electricity distributed uniformly through its mass, and concentrated at one or more points, in general within it, atomic quantities of negative electricity, to which Lord Kelvin gives the name "electrions." A normal atom has the necessary number of electrions to neutralise the positive electricity associated with its matter. The α radiation consists of atoms of matter which have less than the normal number of electrions. When they move into matter they quickly pick up the negative charges necessary to render them neutral, and cease to be detected. The β radiation consists of electrions thrown off during violent oscillations of the atoms of matter, and are readily absorbed by matter. The γ radiation consists of vapour of the radio-active matter, *e.g.* radium, which would possess the penetrative power it is found to have if the Boscovichian forces between the atoms of radio-active matter and ordinary matter were small. The large amount of energy radiated is, according to this view, derived from without the atoms, where it exists in a form which we have not yet found a means of detecting.

Prof. Armstrong pointed out that, as the experiments of Rutherford and Soddy had been made on what was supposed to be radium bromide, the dissociation which they believed to be taking place might be of the compound and not of the element. He was disposed to regard Lord Kelvin's theory with favour.

Mr. Soddy thought ordinary chemical changes were excluded by the fact that the rate of production of the radiations was unaffected by chemical and physical conditions which greatly affected the former. The view Prof. Rutherford and he put forward was that at each stage of the process a new element was formed.

Prof. Dewar gave an account of the experiments on the effects of low temperature on the properties and spectrum of radium carried out partly in conjunction with Sir W. Crookes and recently communicated to the Royal Society.

Prof. Schuster thought the internal energy more probable than the absorption theory, and questioned whether the instability of the atoms predicted by electrical theory would account for the high velocities of the emanations. He was disposed to regard these high velocities as probably due to some cause not yet known.

Prof. Larmor agreed with Prof. Rutherford's theory, and pointed out that, just as atoms of matter must have size, or a half-size atom would still be an atom, so it may be that the atoms of electricity have size and configuration, and thus account for the complicated structure of the radium atom.

Mr. Whetham directed attention to the still unexplained fact that the negatively charged emanation seemed to deposit more readily on negatively than on positively charged bodies, and Dr. Lowry, after recounting some experiments on the flash of light seen when certain substances are crushed, suggested that the emanation might be a modification of a constituent of the atmosphere, *e.g.* helium.

C. H. LEES.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE Southport meeting of Section B proved to be one of the most successful held during recent years; the meetings were largely attended, and a keen interest was exhibited in the proceedings of the section. After the reading of the presidential address (NATURE, p. 472), Prof. J. Campbell Brown described an apparatus for determining latent heats of evaporation, in which a known quantity of heat, generated electrically in a platinum wire, is absorbed in converting a liquid at its boiling point into vapour at the same temperature; very concordant results are obtained.

In a paper on some derivatives of fluorene, Miss Ida Smedley showed that whilst fluorenone $\begin{matrix} C_6H_4 \\ | \\ C_6H_4 \end{matrix} \!\!> C{=}O$, is orange-red in colour, the corresponding sulphur derivative, thiofluorenone, is intensely red; the radicle $>CS$ has thus a greater tendency to produce colour than the carbonyl group. In a paper on the action of diastase on the starch granules of raw and malted barley, Mr. A. R. Ling showed that the starch derived from both raw and malted barley is dissolved and hydrolysed by diastase at a temperature below its gelatinising point, and that the optical and reduction constants differ according to the sample of grain from which the starch is derived. Evidence was adduced in two other papers on the action of malt diastase on potato starch paste, one by Mr. A. R. Ling and the other by Mr. A. R. Ling and Mr. B. F. Davis, that when diastase is heated in aqueous solution at 60°–70° for a short time, the molecule of the enzyme becomes so changed that it no longer yields the same products when it acts on potato starch paste.

Dr. H. C. White described the chemical and physical characteristics of the so-called mad-stone, which, in accordance with a superstition current in the southern States of America, is used to detect and cure the bites of venomous snakes or rabid animals; the mad-stone is found to be a concretionary calculus from the gullet of the male deer, and is devoid of discriminative or curative powers.

Prof. E. A. Letts, Mr. R. F. Blake, and Mr. J. S. Totton read a paper on the reduction of nitrates by sewage, in which it was shown that, when potassium nitrate is added to the effluent from a septic tank, practically all the nitrogen is evolved in the free state or as nitric oxide; the oxygen of the nitrate is evolved as carbon dioxide.

A method for the separation of cobalt from nickel and for the volumetric determination of cobalt was described by Mr. R. L. Taylor; it is based on the fact that cobalt is precipitated quantitatively as a black oxide from neutral solutions by barium or calcium carbonate in presence of bromine water. The black oxide has the composition Co_8O_{14} or Co_7O_{11}.

Prof. J. Dewar, F.R.S., contributed a description of the more recent results obtained from his investigations at low temperatures; he described the methods by which he has succeeded in determining the densities of solid hydrogen, nitrogen, and oxygen, the methods of producing solid hydrogen and nitrogen, and the methods by which he has been able to determine the latent heats, specific heats, and the coefficient of expansion of liquid hydrogen.

A paper on the application of low temperatures to the study of biological problems, by Dr. Allan Macfadyen, is printed in another part of the present issue (p. 608).

Mr. J. Hübner and Prof. W. J. Pope, F.R.S., gave a paper on the cause of the lustre produced on mercerising

cotton under tension, which was illustrated by photographs in natural colours; the lustre of mercerised cotton is proved to be due to a corkscrew-like structure of the mercerised fibre brought about by a simultaneous swelling, shrinking and untwisting which attends the immersion in caustic soda.

Sir H. Roscoe, F.R.S., in presenting the report of the committee on duty-free alcohol, explained the conditions under which the Board of Inland Revenue are now prepared to allow the use of duty-free alcohol for the purposes of research work.

Prof. G. von Georgievics, in a paper on the theory of dyeing, argued strongly in favour of the mechanical as opposed to the chemical theory of dyeing, and claimed that the experimental work upon which the chemical theory is based is erroneous.

In opening a discussion on the general subject of combustion by a paper on the slow combustion of methane and ethane, Dr. W. A. Bone pointed out that his own experimental work showed that, in the combustion of methane, a primary oxidation to formaldehyde and steam occurs, followed by rapid oxidation of the formaldehyde to carbon monoxide, carbon dioxide and steam; in the burning of ethane both acetaldehyde and formaldehyde are formed as intermediate products.

In a preliminary note on some electric furnace reactions under high gaseous pressures, Messrs. J. E. Petavel and R. S. Hutton gave an account of work carried out in an enclosed electric furnace constructed to work with gaseous pressures up to 200 atmospheres. The reactions at present under investigation include the direct reduction of alumina by carbon, the formation of calcium carbide and of graphite, and the production of nitric acid and of cyanogen compounds.

In a paper on the atomic latent heats of fusion of the metals considered from the kinetic standpoint, Mr. H. Crompton showed that, if in the solidification of a liquid energy is lost solely in bringing moving monatomic molecules to rest, a constant can be deduced in a very simple manner from the latent heat of fusion; approximately the theoretical value is obtained for this constant with many of the metals, but not with gallium and bismuth.

Dr. E. P. Perman brought forward a number of results which he has obtained concerning the influence of small quantities of water in bringing about chemical reaction between salts; he investigated more particularly the action of potassium iodide upon salts of lead and mercury. In a paper on the constitution of disaccharides, Prof. Purdie, F.R.S., and Dr. J. C. Irvine described the methylation of cane-sugar and maltose; from experiments on the hydrolysis of the products of methylation they deduced evidence substantiating the constitutions attributed by Fischer to these two disaccharides.

Amongst other papers read in the section may be noted the following:—Stead's recent experiments on the causes and prevention of brittleness in steel, by Prof. T. Turner; the colour of iodides, by Mr. W. Ackroyd; on essential oils, by Dr. O. Silberrad; the cholesterol group, by Dr. R. H. Pickard; on acridines, by Prof. A. Senier; sur le spectre de self-induction du silicium et ses comparaisons astronomiques, by M. le Comte A. de Gramont; fluorescence as related to the constitution of organic substances, by Dr. J. T. Hewitt; freezing point curves of binary mixtures, by Dr. J. C. Philip; mutarotation in relation to the lactonic structure of glucose, by Dr. E. F. Armstrong; the synthesis of glucosides, the preparation of oximido-compounds and the action of oxides of nitrogen on oximido-compounds, by Mr. W. S. Mills; further investigations of the approximate estimation of minute quantities of arsenic in food, by Mr. W. Thomson.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE programme of the geological section of the British Association is usually more or less affected by the geological character of the country around the place of meeting, and this was the case in the present year, though the geology of Southport cannot compare in interest with that of Belfast, Glasgow, or other recent meeting places.

Mr. J. Lomas (Geology of the country around Southport) explained that the solid rock, Keuper and Bunter, is for the most part below sea-level, and only reaches the surface in a few places where it projects through the thick covering of Drift. The Drift is mainly Boulder-clay with an undulating surface, on which are found a number of lake-deposits, left by lakes or meres now partially or wholly drained.

One of these, Martin Mere, was visited by most of the geologists present, and was the subject of a paper by Mr. Harold Brodrick. Upon the Boulder-clay there is a bed of grey clay, which may be of either lacustrine or estuarine origin, and on it grew a forest of oak and Scotch fir. Numbers of trunks of the trees still remain, and Mr. Brodrick remarked that they have usually fallen in a north-east direction. These tree trunks are buried in a bed of peat, which is in places as much as 19 feet thick, and many dug-out canoes have been found in this peat.

The "submerged forest" at Leasowe, in Cheshire, is the remains of a similar mere which has been cut through by the sea, and the peat and tree trunks are now found on the coast below the level of high water. The question whether this points to a depression of the surface of the land was discussed, but the speakers hesitated to give any definite opinion.

Mr. Whitaker read the report of a committee appointed by the council of the Association to record observations on changes in the sea coast of the United Kingdom, and though there was no reference to Southport in the report, its reading was followed by considerable discussion. At Southport itself the land is gaining on the sea, and Mr. Lomas considers this to be due to the large amount of material brought down by the River Ribble. The sand dunes on the coast are, he believes, also due to material brought down by the river, which, drying at low water, is blown inland by the prevailing south-west wind. He remarked that sand dunes are usually found at and near the mouth of a fairly large river.

The question of coast changes was also discussed in a paper on a raised beach in County Cork by Messrs. Muff and Wright, of the Geological Survey. The beach deposits rest upon a platform of solid rock which is some 7 to 12 feet above the corresponding part of the present shore, and the beach deposits are covered by a thick bed of Boulder-clay, showing that they are of early Glacial, if not of pre-Glacial, age. This is almost an exact counterpart of the raised beach in Gower, South Wales, which was described by Mr. R. H. Tiddeman in a paper read before Section C of the British Association at Bradford in 1900.

Mr. Lamplugh (Land shells in the infra-Glacial chalk-rubble at Sewerby, near Bridlington) directed attention to the similarity of these raised beaches to that at Sewerby in Yorkshire. There we find (1) a beach deposit, a few feet above the present high-water mark, banked against an old chalk cliff; (2) a bed of land wash; (3) a bed of blown sand; and upon it (4) a bed of chalk-rubble, in which Mr. Lamplugh has found many specimens of *Pupa muscorum*, a land shell. Consequently the bed is a land wash corresponding to the "Head" of Cork and Gower. The author found this bed on the foreshore at Sewerby, showing that when it was formed the sea stood at a lower level than at the time of the beach deposits. This land wash is underneath all the Glacial Drifts of the Yorkshire coast.

In the discussion which followed the reading of these papers, it was suggested that the raised beaches may be due to an alteration in the level of the sea rather than to earth-movement. Mr. Clement Reid, however, remarked that, though the old sea beaches in Cork, Gower, and Yorkshire are about the same height above the present sea-level, there is at Penzance a well-marked notch in the rock at 65 feet above the sea, and in Sussex there is evidence of a sea-surface not only a few feet above the sea at Selsea, but also as much as 135 feet above the sea in Goodwood Park.

The relations of an estuarine deposit at Kirmington, in Lincolnshire, to the Glacial Drift was the subject of the report of a committee appointed at Belfast last year. The Kirmington Drift deposits are known to rest upon chalk, though the chalk has not yet been reached. A silty sand and chalk-rubble (1) is the lowest bed at present examined; upon it rests (2) a purple clay, no doubt a Boulder-clay, 12 feet thick; and above that (3) sand and chalky gravel 12 feet. Upon this (4) a thin fresh-water bed has now been found; and (5) a clay with estuarine shells, the whole being under (6) a second bed of Boulder-clay. The estuarine bed

with a fresh-water layer at its base is thus shown to be between two Boulder-clays, and the committee hopes to carry operations down to the Chalk before the meeting of the Association next year.

The report of the committee on Irish caves described explorations in some caves at Edenvale, near Ennis. Remains of man, associated with those of the bear, reindeer, &c., were recorded.

Implements, mainly Palæolithic, from the district between Reading and Maidenhead were dealt with in a paper by Mr. Llewellyn Treacher. He has obtained them in considerable numbers from gravels at levels of from 60 to 120 feet above the river Thames. The implements are usually of flint, but two examples of implements made from quartzite pebbles were described. The geological history of these pebbles is well known; they are from the Triassic pebble beds of the Birmingham district, and were brought into the Reading country by the River Thames in an early part of its history, when it drained an extensive tract now within the drainage area of the River Severn. Such pebbles are abundant in the old Thames Gravel, which caps much of the high ground north and north-west of Reading up to a level of about 500 feet above the sea, and no doubt the makers of the implements obtained the pebbles from the old Gravel.

The Swiss geologist, M. André Delebecque, read a short but very interesting paper on the lakes of the Upper Engadine. The lake of St. Moritz is, he said, obviously a rock basin, whilst the lakes of Sils, Silva Plana, and Campfer were, he believed, once a single lake also filling a rock basin. The torrents descending from side-valleys have now partially filled up this basin and divided it into the three lakes.

This paper led to a discussion on the origin of rock-basins. The author thought that, though Glacial erosion could hardly take place in very compact rocks, yet in many places even granite and gneiss become much decomposed, and glaciers may have swept away the decomposed rock and thus have produced hollows. Mr. Marr considered that every region containing rock-basins must be studied by itself, and that they are probably the result of many different causes.

Mr. Lamplugh said that, in regions of extreme Glacial erosion, we find true rock-basins near the gathering ground of ice, but as we approach the margin of the glaciated area we find lakes due to terminal moraines, kettle holes, &c.; thus in the marginal areas the lakes are not the result of direct ice-erosion, but are due to secondary causes.

Mr. Clement Reid said it was unfortunate that in north Europe the ice had so completely cleared away the soft deposits of the late pre-Glacial age that we have very little evidence as to the age of the lake or rock-basins.

In south Europe such evidence is often to be found, and he mentioned a case in Italy, near Florence, where there have been three lakes; the lowest, now silted up, is of about the age of our Cromer Forest Bed, the second, also filled up, is a Pleistocene lake, whilst the third, and highest, still exists as a lake. The speaker suggested that these lakes were due to earth-movements in a direction at right angles to the valley.

Passing to petrography, Mr. Teall contributed a most interesting paper on dedolomitisation. Taking a cherty dolomite, such as that of Durness, he showed that it has been dedolomitised by the formation of magnesian silicates, whereas in the case of the marbles formed of calcite and brucite it may be inferred that, under the conditions which prevailed during the intrusion of the plutonic rocks, the carbonic acid freed itself more readily from the magnesia than from the lime, thus in the absence of silica giving rise to the formation of periclase and converting the original dolomite into an aggregate of calcite and periclase, the periclase having been subsequently changed to brucite. The author instanced the predazzite of the Tyrol as a rock probably formed in this latter way. The history of the rock would then be as follows:—(1) formation of the limestone; (2) dolomitisation; (3) intrusion of igneous rock and dedolomitisation in consequence of the development of silicate or periclase; (4) hydration.

Mr. G. W. Lamplugh, whose name is well known in connection with the study of crush-breccias and conglomerates, read a paper on the disturbances of junction-beds from differential shrinkage and similar local causes during consolidation. He thought that in many cases rock was indurated before it became covered up by the succeeding strata, and that many of the curious structures we see in calcareous rocks may have been due to hardening before anything was laid on top of them. He instanced structures common in the Chalk and Lower Cretaceous rocks. He suggested that shrinkage during consolidation may account for the peculiar appearances which we sometimes see where a thin clay or shale is interbedded with thick sands, such as in the Hastings Sands, or at a junction such as that of the sand of the Lower Greensand with an underlying clay.

Mr. J. Lomas referred to a similar problem in a paper on Polyzoa as rock-cementing organisms.

The difficult question of the distinction between intrusive and contemporaneous igneous rocks was raised in papers by Mr. W. S. Boulton and by Messrs. T. H. Cope and J. Lomas, and was discussed at some length.

Mr. Boulton dealt with the basaltic rock associated with the Carboniferous Limestone at Spring Cove, Weston-super-Mare. The igneous rock shows a marked pillow-structure, contains tuff and agglomerate, and includes lumps and masses of the limestone.

The tuff within the sheet behaves like a lava showing flow structure, and is clearly not the result of sedimentation. The author believes the included limestone-fragments were derived from the underlying calcareous floor when it was a sea-bottom, the masses having been rolled and picked up by the lava, and thus become intercalated between its spheroidal masses. He thought the igneous rock was a submarine flow of lava. Messrs. Cope and Lomas dealt with the igneous rocks of the Berwyns. The district has a dome-like structure, shales and limestones of Llandeilo age being exposed on the top of the dome, whilst the newer Bala beds form a ring around. There are four thick sheets of rock which have hitherto been regarded as contemporaneous volcanic ashes. The authors, however, believe them to be intrusive igneous rocks.

Mr. J. G. Goodchild (Some facts bearing on the origin of eruptive rocks) contended that intrusive masses, as a rule, replace their own volume of the rocks which they invade, and do not cause displacement to any important extent. This paper gave rise to some discussion, for there were present many believers in the existence of laccolites. One speaker suggested that the presence of flow structure along the margins of intrusive igneous rocks was scarcely in harmony with the author's views. It was, however, admitted that there were difficulties when a dyke ends upwards or laterally against strata.

The palæontological papers were of considerable interest. Mr. A. C. Seward, president of the botanical section, read a paper before Section C on the fossil floras of South Africa. He considers that the plants from the Uitenhage series of Cape Colony are of Wealden age, and assigns those from the Stormberg Series to the Rhætic period. With regard to the Vereeniging plants, he describes them as belonging to a flora which flourished in South Africa, India, South America, and Australia during some portion of the Permo-Carboniferous epoch, perhaps that part nearly corresponding to the Upper Carboniferous of Europe. We have, he said, in South Africa as in South America, evidence of an overlapping or commingling of the northern and southern botanical provinces.

The Carboniferous flora of the Ardwick series of Manchester was the subject of a paper by Mr. Newell Arber, and some additional details as to the Carboniferous Mollusca were furnished in the report of the committee on life-zones in the rocks of that period.

Dr. Smith Woodward described an Acanthodian fish, Gyracanthides, from the Carboniferous of Victoria, Australia, and in illustration of another paper he exhibited some fragments of bone from Brazil. They were from a Red Sandstone formation, probably of Triassic age, and it had been suggested that they belong to an Anomodont reptile.

Mr. W. G. Fearnsides (on the Lower Ordovician rocks in the neighbourhood of Snowdon and Llanberis) gave an account of his discovery of fossils round the south-west and north-west flanks of Snowdon, from Criccieth to Llanberis. They are in beds corresponding to the well-known South Wales Llanvirn series, and are the first fossils recorded from beds on Snowdon older than the fossiliferous Bala ash of the summit.

Finally, the committee appointed last year to investigate the fauna and flora of the Trias of the British Isles made its first report. It was written by Mr. H. C. Beasley, and deals with cheirotheroid foot-prints. The attendance at the meetings of the section was good, and on several occasions the papers led to animated and interesting discussions.

H. W. M.

ZOOLOGY AT THE BRITISH ASSOCIATION.

THE president's address—which was postponed until Friday, September 11, in order to avoid the hours fixed for the opening addresses in the other biological sections—dealt first with the inadequacy of the public provision made for the advancement of zoology and its applications in this country, and secondly with some considerations bearing on the problems of variation and heredity, more especially as seen in the Cœlenterata. In fact, influenced no doubt by the personal work of the president, a considerable number of the communications brought before the section this year dealt with the Cœlenterata, especially with corals and coral reefs.

Thursday, September 10.—The forenoon was given up to coral papers, and the afternoon mainly to reports of committees. Dr. J. E. Duerden (from the United States) gave two papers, "Septal Sequence in the Coral Siderastræa" and "Morphology and Development of Recent and Fossil Corals"—these being some of the results of the author's studies of living West Indian corals while he served as curator of the museum at Jamaica. He directed attention to the general occurrence of boring filamentous Algæ, and to the fact that the colours of West Indian corals are mainly due to the presence of symbiotic yellow cells (zooxanthellæ) in the endoderm. Mr. C. Crossland had a paper describing the coral formations he met with on the east coast of Africa, near Zanzibar, and Mr. Stanley Gardiner gave a general account of the coral reefs of the Indian Ocean. In connection with this, Prof. Herdman directed attention to the fact that, in the Gulf of Manaar, calcareous masses ("calcretes") of great extent are formed *in situ* on the sea-bottom by the cementing of sand and other loose material by calcareous incrusting Polyzoa. Miss Edith Pratt had a paper on the assimilation and distribution of nutriment in *Alcyonium digitatum*. The polypes exercise choice, and feed mainly on small Crustacea. Miss Pratt regards the so-called nerve-plexus as part of a system of amœboid endoderm cells conveying nutriment throughout the colony. Prof. Hickson described a case of polymorphism in a *Pennatula murrayi* from eastern seas. Dr. J. Cameron gave a lantern demonstration on the origin of the epiphysis in Amphibia as a bilateral structure.

The reports of committees were as follows:—(1) On bird migration in Great Britain and Ireland. This is the final report, and consists chiefly of Mr. Eagle Clarke's observations on the starling and the rook. (2) Naples Zoological Station. This includes a detailed account, by Mr. W. Wallace, of his investigations on the oocyte of Tomopteris. (3) "Index Animalium." The first volume, dealing with the period 1758–1800, has been issued, and the indexing of 1801–1900 is now being continued by Mr. Sherborn. (4) Zoology of the Sandwich Islands. This is the thirteenth report, and the work is still in progress. (5) Coral reefs of the Indian region. (6) Plymouth Marine Laboratory. (7) Millport Marine Laboratory. As on this occasion the physiological section did not meet separately, the physiological papers were taken in Section D. These included two reports:—(1) The microchemistry of cells. This dealt chiefly with the localisation of potassium in the living cell, and was drawn up by Prof. A. B. Macallum. (2) The state of solution of proteids.

Friday, September 11.—After the presidential address came a paper by Dr. Gamble and Mr. Keeble on the bionomics of *Convoluta roscoffensis*, with special reference to its green cells. This was followed by three short notes by Prof. R. J. Anderson—the skull of *Ursus ornatus*, the skull of *Grampus griseus*, and the peritoneum in *Meles taxus*. The section did not meet on Saturday.

Monday, September 14.—The morning was devoted to a joint discussion with botanists on fertilisation, in which the president, Prof. Hartog, Prof. Bretland Farmer, Mr. W. Bateson, Mr. M. D. Hill, and Mr. Jenkinson took part. The following papers were then read:—M. D. Hill, on nuclear changes in the egg of Alcyonium; Prof. Hartog, on the function of chromatin in cell division, and on the tentacles of Suctoria; Prof. Hickson, on conjugation in Dendrocometes (demonstrated with slides); J. W. Jenkinson, on some experiments on the development of the frog; Dr. Leighton, on British reptiles; N. Annandale, on the coloration of Malayan reptiles; H. C. Robinson, on the walking fish of the Malay Peninsula, and also an exhibition of convergent series of Malayan butterflies.

Tuesday, September 15.—Prof. Herdman gave a short account of a remarkable phosphorescence phenomenon observed in the Indian Ocean, which led to descriptions of other similar occurrences by the president, Mr. Stanley Gardiner, Mr. Bateson, and others. Prof. Herdman then read a joint note by Mr. James Hornell and himself on pearl-formation in the Ceylon pearl oyster, giving a biological classification of pearls into (1) ampullary, (2) muscle pearls, and (3) cyst pearls. The remaining papers were mainly physiological in their bearing, viz. Captain Barrett-Hamilton, on a physiological theory of the winter whitening of animals; Prof. B. Moore, on a new form of osmometer for direct determinations of osmotic pressure of colloids, and also experiments on the permeability of lipoid membranes; Prof. Sherrington and Dr. Grünbaum, on the cerebrum of apes; Mr. J. Barcroft, on the origin of water in saliva; Dr. Greaves, demonstration of visual combination of complementary colours; Mr. C. V. Hughes, note on two rare birds; Dr. Rennie, on epithelial islets in the pancreas of Teleosteans; Mr. D. C. McIntosh, on variation in *Ophiocoma nigra*; and Prof. W. C. M'Intosh, on the eggs of the shanny. Dr. Rennie suggests that his epithelial islets are blood-glands which have entered into a secondary relation to the pancreas, and that they maintain their primitive function of producing an internal secretion.

The section did not meet on Wednesday, but on Thursday, September 17, there was a dredging expedition, in which the president and a number of the members of Section D took part. The expedition was in the Lancashire Sea-Fisheries steamer, *John Fell*, kindly lent for the purpose by the committee, and was under the leadership of Mr. Dawson (Superintendent of Fisheries), Mr. Isaac Thompson (of the Liverpool Marine Biology Committee), and Prof. Herdman. The first hauls of the fish and shrimp trawls were taken in the shallow waters off Southport and the estuary of the Mersey, in order to show the fauna of the characteristic Lancashire small-fish "nurseries"; a visit was paid to the local shrimping fleet, a fishing boat was overhauled and boarded and its nets examined, and the other routine operations of the fisheries steamer in policing and inspecting the district were fully explained to the party. The processes of taking the physical observations, and of examining, counting, and recording a haul of the trawl were also gone through. Later in the day dredging and tow-netting took place further out to sea on harder ground with a more varied fauna. Although not strictly part of the work of the section, this dredging expedition made an interesting and appropriate finish to a very successful zoological meeting.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. SYDNEY YOUNG, F.R.S., professor of chemistry in University College, Bristol, has been appointed to the chair of chemistry in Trinity College, Dublin, vacant by the resignation of Prof. Emerson Reynolds.

ONE of the two open entrance scholarships which were recently founded at the Victoria University of Manchester, each of the value of 100*l*., has been awarded to Mr. W. C. Denniston.

DR. JOHN WHITE, of the University of Nebraska, has been appointed head of the department of chemistry at the Rose Polytechnic Institute, succeeding Prof. W. A. Noyes, who was recently appointed chief chemist of the American National Bureau of Standards.

THE course of Saturday morning lectures on the teaching of mathematics, which the London Technical Education

Board announced would be commenced by Prof. Hudson at King's College, Strand, on October 17, has been postponed until next term, and will begin on January 23, 1904.

AT a special convocation of the University of Toronto on October 2, the following honorary degrees were conferred, in connection with the opening ceremonies of the new physiological and medical laboratories:—LL.D. (*honoris causa*), Prof. W. W. Keen, Jefferson Medical College, Philadelphia; Prof. W. H. Welch, Johns Hopkins University; Prof. William Osler, F.R.S., Johns Hopkins University; Prof. R. H. Chittenden, Yale University; Prof. Charles S. Sherrington, F.R.S., University of Liverpool. *In absentia*, Prof. H. P. Bowditch, Harvard University. The inaugural address at the opening of the laboratories was delivered by Prof. Sherrington.

THE new buildings of the Essex County Technical Laboratories, Chelmsford, will be opened by the Earl of Onslow, President of the Board of Agriculture, on Friday afternoon, October 30. The buildings, which have just been completed at a cost of nearly 12,000*l.*, comprise chemical, physical and biological laboratories and class-rooms, together with agricultural and horticultural museums and libraries, and provide facilities for systematic instruction in agriculture and horticulture, as well as in pure science. The laboratories are intended to be a centre for agricultural and horticultural information for the whole county, and they include rooms for the analysis of soils, manures, foods, seeds, &c., and for other scientific work carried on in the interest of these industries.

IN reply to a memorial to the Board of Agriculture, asking that ordnance maps might be sold at reduced prices for teaching purposes, the Geographical Association has been informed that the Board is prepared to authorise the Ordnance Survey Department to produce and supply to educational authorities a special edition of the outline 1-inch maps, printed on cheap but reasonably strong paper, at the following prices:—200 copies, 1*l.* 5*s.*; 500 copies, 2*l.*; 1000 copies, 3*l.*; 5000 copies, 12*l.* For larger numbers the estimated price would be 2*l.* per 1000 copies. The Board has stipulated that any maps thus supplied should not be sold, and a heading is to be printed on the maps to this effect. Referring to the educational advantages of the Board's decision, Dr. Herbertson, secretary of the Geographical Association, remarks:—"It is universally agreed that all sound geographical teaching must begin in a study of the home region, and it is therefore to be hoped that most teachers will avail themselves of the facilities so generously granted, either individually or by making application through the local education authority."

MUCH of the success of the Glasgow and West of Scotland Technical College could probably be traced to the wide-spread interest in its work shown by the Corporation of Glasgow, by Scottish manufacturers and merchants, and by the associations both of professional men and of artisans. The most recent annual report of the governors of the college provides many indications of the belief in the value of higher technical education by the inhabitants of Glasgow and its neighbourhood. The Corporation of Glasgow has made a grant of 5000*l.*, of which 4500*l.* was towards working expenses and 500*l.* towards the building fund; many manufacturers and others have given facilities for visits to their works by parties of students, and many merchants have made additions to the college equipment or have supplied laboratory material. It is of interest to note that the total expenditure involved by the erection of the new buildings, the foundation stone of which was laid last May by the King, exclusive of equipment, will be not less than 210,000*l.* Of this sum the governors are able to announce promises of donations and grants amounting to 182,382*l.*

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 7.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. G. C. **Champion** exhibited on behalf of Prof. Hudson **Beare** some specimens of a Ptinus new to the British list, captured in a granary at Strood on May 11, 1901.—Mr. C. O. **Waterhouse** exhibited on behalf of Mr. Charles **Pool** specimens of a beetle of the genus Niphus, closely resembling *N. crenatus*, but with distinct shoulders, and more parallel elytra which are less strongly striated. They were found in large numbers in a corn chandler's at Edmonton.—Mr. H. St. J. **Donisthorpe** exhibited specimens of *Aphanisticus emarginatus* from the Isle of Wight, a beetle new to the British list, and a Scymnus, new to science, from the same locality.—Mr. M. **Burr** exhibited a living adult male earwig, *Labidura riparia*, Pall., captured near Boscombe at the end of August. He said that the very noticeable pale coloration becomes darker after death, sometimes nearly black, which might account for some of the numerous "colour-varieties."—Dr. Norman **Joy** exhibited a specimen of *Argynnis selene*, taken last year in Berkshire, showing a remarkable tendency to melanism, and rare Coleoptera taken in the same county during 1903.—Sir George **Hampson** exhibited a collection of Norwegian butterflies made by him on the Dorsefjeld, on the Alten fiord, at Bossekop, and other localities this year, including series of *Colias hecla*, Lef., *Chrysophanus hippothöe*, and var. *stieberi*, Gerh., *Œneis norna*, Thnb., *Melitaea*, var. *Norvegica*, Auriv., the Norwegian form of *M. aurelia*, *Argynnis freiga*, and *A. frigga*, a Labrador, Arctic, and North American species, now found further south, at Kongsvold, for the first time.—Mr. A. H. **Jones** exhibited examples of *Erebia christi*, taken this summer in the Laquinthal, and of the species of Erebia, to which it is allied; a local form of *Satyrus actaea*, var. *cordula*, from Sierre; and a short series of *Chrysophanus dorilis* (type) and *C.* var. *subalpina* from the Laquinthal, with *P. hippothöe*, var. *eurybia*, showing the strong resemblance on the upper surface which the ♀ of this latter species bears to the ♀ *subalpina*.—Mr. A. J. **Chitty** exhibited specimens of *Procto trupid*, which he said approached *Poncra constricta* in appearance, but might be an Isobrachium. If so, it was new to the British list.—Mr. H. Willoughby **Ellis** exhibited *Criocephalus polonicus*, Motsch, a longicorn beetle new to Great Britain, from the New Forest, and also specimens of all stages, from the egg to the imago, to illustrate the life-history of the species. He also exhibited specimens of *Asemum striatum*, L., with larva and pupa, accounted heretofore rare in the New Forest, but this year occurring in abundance.—Mr. Ambrose **Quail** exhibited cases showing the life-history of some Australian Hepialidæ.—Dr. D. **Sharp,** F.R.S., exhibited specimens illustrative of the egg-cases and life-histories of eight species of South African Cassididæ, as described in a paper by Mr. F. Muir and himself.—Mr. W. L. **Distant** also showed the pupa cases of some African species of Aspidomorpha, with the cast heads of the larvæ.—Mr. Roland **Trimen,** F.R.S., exhibited some cases of mimicry between butterflies inhabiting the Kavirondo-Nandi district of the Uganda British Protectorate, particularly that in which *Planema poggei*, Dewitz, is imitated by an apparent variety of *Pseudacraea künowii*, Dewitz, and also by a hitherto undescribed form of the polymorphic ♀ *Papilio merope*, Cram. He mentioned that both *Planema poggei* and *Pseudacraea künowii* were described and figured by Dewitz in 1879 from single specimens taken by Dr. Pogge in Angola, and added the interesting fact that the only other example of the undescribed mimicking form of the ♀ *Papilio merope* known to him—in the Hope Department of the Oxford University Museum—is ticketed "Angola; Rogers, 1873." The president referred to the special interest attaching to an interpretation of this remarkable form of the female *merope*; at the same time he pointed out that the interpretation so convincingly illustrated that evening had been made out last spring by Mr. S. A. Neave, who exhibited this form of the female *merope*, together with *Planema poggei* as its model, at both *soirées* of the Royal Society in May and June, a time when Mr. Trimen's absence from England unfortunately prevented him from seeing them.—Dr. T. A. **Chapman** exhibited *Coenonympha oedipus*, *Satyrus dryas*, and *Heteropterus morpheus*, taken last summer near Biarritz, and *Erebia crias* and *E. stygne*, from the Logroño Sierra, Spain. These he suggested were probably examples of homœochromatism. Little attention has been directed to homœochromatism in European butterflies, and these were certainly not examples of the detailed mimetism we are now familiar with in Müllerian groups from the African

and neotropical regions.—Dr. **Chapman** also exhibited living imagines of *Crinopteryx familiella*. These had just emerged at Reigate, where they and their parents, descended from pupæ brought from Cannes in March, 1901, had lived out of doors during their active existence, being brought into the house only during their pupal æstivation. This seemed noteworthy in so southern (Mediterranean) a species. The experiment seemed quite likely to continue successful for the next generation.—Mr. Ambrose **Quail** read papers on the antennæ of the Hepialidæ and on *Epalxiphora axenana*, Theyr.—Mr. Gilbert J. **Arrow** read a paper on the laparostict lamelicorn Coleoptera of Grenada and St. Vincent, West Indies.—Mr. T. H. **Taylor** communicated notes on the habits of *Chironomus* (*orthocladius*) *sordidellus*.—Mr. F. Du Cane **Godman**, F.R.S., communicated descriptions of some new species of Erycinidæ.—Mr. W. L. **Distant** communicated additions to the rhynchotal fauna of Central America.—Dr. D. **Sharp**, F.R.S., read a paper on the egg-cases and early stages of some Cassididæ.

PARIS.

Academy of Sciences, October 12.—M. Albert Gaudry in the chair.—The perpetual secretary announced to the Academy the death of Prof. Rudolf Lipschitz, correspondant for the section of geometry.—On the relations between the theory of double integrals of the second species and that of the integrals of total differentials, by M. Émile **Picard**.—On the temperature of inflammation and on the slow combustion of sulphur in oxygen and in air, by M. Henri **Moissan**. The temperature of inflammation of sulphur is 282° C. in oxygen and 363° in air, at atmospheric pressure. Sulphur dioxide can be detected after twelve hours at 100° C., giving a distinct quantity of solid at −186°.—Palæontological observations in Alaska, by M. Albert **Gaudry**. The abundance of mammoth remains near Yukon leads to the conclusion that at a far distant epoch the climate was far less severe than at present.—On the new function $E_a(x)$, by M. G. **Mittag-Leffler**.—The detection and estimation of urea in the tissues and in the blood of vertebrate animals, by M. Nestor **Gréhant**. The alcohol extract is evaporated at 50° C., the residue treated with nitrous acid, and the gases pumped out, the carbon dioxide being measured. Both the blood and muscles of mammals were found to contain urea, of birds, none.—On linear equations of finite differences, by M. Alf. **Guldberg**.—On the working of coherers, by M. Albert **Turpain**.—Contact electrification and the theory of colloid solutions, by M. Jean **Perrin**. If a substance in contact with water takes a strong electrification and small surface tension, the stable state of the system will be realised by an emulsion of granules of fixed diameter, dispersed in the water.—The action of carbonic acid under pressure on metallic phosphates, by M. A. **Barillé**.—On a series of bismuth compounds, by MM. G. **Urbain** and H. **Lacombe**. From an examination of the double nitrates, the author concludes that bismuth stands in the same relation to the rare earths as zinc does to magnesium.—On the estimation of vanadium in metallurgical products, by M. Em. **Campagne**. The metal is converted into chloride, the bulk of the ferric chloride removed by ether, and the vanadium converted into $VOCl_2$ by evaporation with hydrochloric acid. This is converted into sulphate, and titrated with permanganate.—On the nitric esters of the alcohol-acids, by M. H. **Duval**. The preparation and properties of the nitrates of glycollic, malic, and glyceric acids are described.—The abnormal fixation of trioxymethylene on certain organo-magnesium derivatives, by MM. M. **Tiffenau** and R. **Delange**. The compound obtained by the action of magnesium upon benzyl chloride behaves abnormally with trioxymethylene, giving orthotolyl alcohol, $CH_3.C_6H_4.CH_2OH$, instead of the phenyl-ethyl alcohol, $C_6H_5.CH_2.CH_2OH$, which might have been expected. The magnesium compound, however, possesses the normal constitution, $C_6H_5.CH_2.Mg.Cl$, as is shown by the production of phenylacetic acid by the action of carbon dioxide.—The action of mixed organo-magnesium compounds upon amides: a new method for the preparation of ketones, by M. Constantin **Béis**. When an amide is heated on the water bath with an excess of an organo-magnesium compound, and the product treated with water, ketones are produced. Methyl-ethyl-ketone, diethyl-ketone, methyl-propyl-ketone, isobutyl-ethyl-ketone, acetophenone, and phenyl-ethyl-ketone have been prepared by this method, which appears to be of general application.—On the oscillatory movements of *Convoluta roscoffensis*, by M. Georges **Bohn**.—On the vegetative apparatus of the yellow rust of cereals, by M. Jakob **Eriksson**.—The necessity of a microbial symbiosis for obtaining a culture of the Myxomycetes, by M. **Pinoy**.—On a new mineral species, by M. A. **Lacroix**. The mineral, which is named grandidierite, has the composition

$$7SiO_2.11(Al,Fe)_2O_3.7(Mg,Fe,Ca)O.2(Na,K,H)_2O,$$

and is one of the most basic silicates known. It was found in South Madagascar.—On the Turonian of Abou Roach (Egypt), by M. R. **Fourtau**.

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 23.

PHYSICAL SOCIETY, at 5.—The Bending of Magnetometer Deflection-Bars: Dr. C. Chree, F.R.S.—On the Magnetism of Basalt and the Magnetic Behaviour of Basaltic Bars when Heated in Air: Dr. G. E. Allen.—Some Experiments with Electrical Oscillations: Dr. W. Watson.

SATURDAY, OCTOBER 24.

ESSEX FIELD CLUB.—Annual Cryptogamic Meeting at High Beech, Epping Forest; Referees: Dr. M. C. Cooke and Mr. George Massee.

SATURDAY, OCTOBER 31.

ESSEX FIELD CLUB, at 6.30.—Exhibition of a Series of Photographs of Fungi, by means of the Lantern: Mr. Somerville Hastings.—Seed Dispersal: Prof. G. S. Boulger.

CONTENTS.

THURSDAY, OCTOBER 29, 1903.

VECTORS AND ROTORS.

Vectors and Rotors, with Applications. By O. Henrici, Ph.D., LL.D., F.R.S., and G. C. Turner, B.Sc. Pp. xv + 204. (London: Edward Arnold, n.d.) Price 4s. 6d.

PROF. HENRICI can always be depended upon to embellish any mathematical subject which he touches, because, with the skill of the analyst, he combines the keen perception of the geometer, which ever seeks to render the results of analysis in some way visible by spatial representation—or, perhaps, to reach the results directly (and often more simply) without any aid from analysis at all. To a mathematician of this kind the subject of vector analysis is peculiarly appropriate. We are therefore indebted to Mr. Turner for putting into systematic form the lectures delivered by Prof. Henrici at the City and Guilds Technical College, and producing a very simple and elementary work the methods and ideas of which should find a very early introduction into our ordinary mathematical teaching.

The system here put forth is non-Hamiltonian. A vector is throughout a mere "carrier." With Hamilton it was this and more; every unit vector, when employed as a factor, said Hamilton, is to be regarded as a quadrantal versor the plane of which is perpendicular to the vector. In the non-Hamiltonian system the vector is not in any way associated with the notion of rotation. Some vectors are, except as regards *direction* and *sense*, absolutely unrestricted in space; others (such as forces acting on a body) are restricted to definite right lines and are called *localised vectors*. For these latter the special name of "rotors" has been invented, and Prof. Henrici must excuse an adherent of the Hamiltonian system for saying that this name seems to be wholly unjustified in a system which refuses to associate the notion of a rotational operation with any vector. Assuming that a "rotor" means, perchance, a "rotator," how comes it that such a name is applied to a mere "carrier"? There is another term also adopted by Prof. Henrici the justification of which is at least difficult, viz. the term "ort." A vector of unit length is called an "ort," which is explained to be "short for orientation," and "orientation" makes a dangerous suggestion of rotation. The "ort" is, of course, Hamilton's *unit vector*. The "rotor" and the "ort" should be regarded by anti-Hamiltonians as the trail of the serpent.[1]

The contrast between the two systems is well illustrated by the discussion of the product, $\alpha\beta$, of two vectors, α and β, which forms the subject of chapter iii. of Prof. Henrici's book. With Hamilton the nature of the expression follows simply and naturally; $\alpha\beta$ means α/β^{-1}, an operation implying rotation—the conversion of the vector β^{-1} into the vector α. It can therefore be taken as either a combined tensor and versor operation, or a combined scalar and vector operation. This at once gives us the complete specification of the vector of $\alpha\beta$, and also that of the scalar of $\alpha\beta$, making the latter equal to $-ab\cos\theta$, where a and b are the tensors of α and β, and θ the angle between them.

Prof. Henrici, by a very simple and consistent rule, specifies the vector part and makes it identical with Hamilton's specification, but he makes the scalar $+ab\cos\theta$, by what, after all, amounts to a perfectly arbitrary and dogmatic definition (p. 95), its systematic connection with the mode of defining $V\alpha\beta$ being somewhat strained and unconvincing.

This, however, is a matter of no consequence, since he is quite at liberty to lay down his own definitions, inasmuch as he is not hampered by the Hamiltonian notion of rotation as associated with a vector.

As regards notation in this part of the subject, it may be pointed out that Prof. Henrici uses $[\alpha\beta]$ for the Hamiltonian $V\alpha\beta$, and (α,β) instead of $S\alpha\beta$, which certainly does not seem to be an improvement, especially when we have to write down a long vector or scalar equation—such, for example, as (iii.), p. 199. Again, the notation $[\alpha|\beta+\gamma]$, instead of $V\alpha(\beta+\gamma)$, is scarcely pleasing to the eye, even if it is not calculated to lead to slips in working.

The only indication that Prof. Henrici gives of his view of the quaternion system is found in p. 104, where he dispenses with the operation of division by vectors. "This operation is complicated and will not be considered at all. It leads to the much more complicated Theory of Quaternions." It is, however, quite open to a Hamiltonian to say nothing about division of vectors; he can treat his vectors as mere "carriers," and claim all the results of a non-Hamiltonian theory as his own; for a non-Hamiltonian is not necessarily an anti-Hamiltonian theory. It remains, of course, quite true that with Hamilton division is the primary notion, and multiplication the secondary.

The subjects selected by Prof. Henrici for vector treatment are geometrical and statical. Almost all the prominent results of elementary geometry are shortly and neatly obtained, and among the illustrations of this subject are the Peaucellier and Hart mechanisms for the description of a right line. There is a very full discussion of centres of mass, and a planimetric method of finding the centre of mass of any area, which method is not so well known as it ought to be. The determination of the centre of parallel forces by the use of link (or funicular) polygons is fully explained, while—to the great advantage of the student—Prof. Henrici is very lavish of his figures.

So very few elegances escape the watchful eye of Prof. Henrici that one feels a pleasure in pointing out something that he might have included in his discussion of force systems. The centre of a parallel system of forces is known to everyone, but the *astatic centre* of a system of coplanar forces has received little attention. Yet it is a striking entity, and one which is closely allied to the other centre. Its definition is fairly well known; perhaps the best specification of it treats it as the point of intersection of the line of no moment with the line of no virial.

The portion of the book dealing with statics treats largely of the stresses in frameworks, shearing forces, bending moments, &c., the treatment being, of course,

[1] Prof. A. Lodge suggests the term "locor" for rotor.

all vectorial, that is, geometrical, and marked by great clearness of exposition. Such a treatment of statics forms a most needful corrective of the methods of a purely "analytical statics," which has a strong tendency to keep the subject aloof from reality, and to obscure its physical nature. "One does not find figures in this book," boasted Lagrange in his "Mécanique Analytique," but the absence of geometrical methods and conceptions is not to the advantage of the subject.

In the penultimate chapter Prof. Henrici gives a short, very useful, and well explained account of the reciprocal figures of graphic statics, and the last chapter is a very short one on the deduction of the elementary trigonometrical formulæ from vector methods. With all deference to the author, however, it is to be feared that pupils will not, within time at the earth's disposal, be so much accustomed to think in vectors as to deduce their notions of a sine and a cosine otherwise than by the old method.

Next to the systematic teaching of the solution of all kinds of equations by graphic constructions, the wider employment of geometrical methods in dynamics is our greatest desideratum, and for this reason we have to thank Prof. Henrici for this elegant little treatise.

GEORGE M. MINCHIN.

THREE PROTOZOAN ARTICLES.

A Treatise on Zoology. Edited by E. Ray Lankester, LL.D., F.R.S., &c. Part i. Introduction and Protozoa. Second Fascicle. Pp. vi+451. (London: A. and C. Black, 1903.) Price 15s. net.

THE erratic order in which the various volumes of Prof. Lankester's treatise are appearing is, from the nature of their subject, a matter of very little consequence, and we are glad to welcome now this instalment of the protozoan chapter. It is the second fascicle of part i., of which the first fascicle, containing the introduction and the groups not here included, has still to appear. The inconvenience of the intended arrangement of parts is clearly demonstrated, and it is very fortunate that it has not resulted in the detention at the press of the valuable essays which make up this volume. A large part of the editor's difficulties have resulted, it is clear, from his adherence to the plan of producing bound volumes of nearly uniform size—in following, that is to say, the mode of publication of the recent "Cambridge Natural History" and of other similar works of collaboration. We believe it would prove to be in the interest of authors and readers alike if no attempt were made by the editors of series of this kind to produce periodically completed volumes, and if the separate articles were issued uniformly, but unbound, in the style of German monographs. The total expense to the purchaser of the whole series could remain the same by an obvious arrangement, while the gain to many specialists would be immense. We have a case in point in the present volume. Prof. Minchin's valuable monograph on the Sporozoa occupies about one-half of the whole volume, and might, we gather, have been already for some time in our hands if it had appeared separately in paper covers. Its subject is precisely one in which publication might well have been both early and individual in the interests of the medical profession, for which it has, perhaps, its chief importance at the present time. The deliberate manufacture of volumes, as such, while we can see nothing at all to recommend it, is exposed at the same time to the serious objection of stimulating over-production. The publication of a complete "Cambridge Natural History," and now of what is virtually an Oxford treatise, suggests inevitably that among the whole body of English zoologists a good deal of research has been recently sacrificed to text-book writing, of which a large part, however conscientious, has been redundant.

We can say this now with the greater assurance, because it cannot be taken as applying to the excellent articles on the Foraminifera, the Sporozoa, the Ciliata, and the Acinetaria in the present volume. The section dealing with the Sporozoa, by Prof. Minchin, takes its place as an admirable systematic account of the group, prefaced by a general sketch of their characters and of the typical life-history. The recent developments of our knowledge of sporozoan parasites in connection with malarial disease give a special importance, as we have said, to this monograph. Prof. Minchin provides in his description of the Hæmosporidia exactly what is now becoming essential knowledge for the student of disease, and it is highly desirable, we think, that medical men should approach the study of this group from a more general point of view than that permitted in the restricted accounts of the malaria parasite written specially for their use. In the interests of further developments of curative and preventive treatment in new directions, it is of the first importance that the morphology and life-cycles of the members of this group should be completely determined, although, as the author claims, "the life-cycle of the malarial parasite is now thoroughly known in all its features." The recent work of Schaudinn, who has explained the occurrence of relapse in malaria without fresh infection as due to a kind of parthenogenetic reproduction by resistant and long-lived macrogametocytes, is an example of the value in these inquiries of a zoological outlook, and it is to be remembered that the "black spores" of Ross have not yet been assigned with certainty to their place in a life-cycle. With regard to the voluminously alleged connection between the Sporozoa and cancer, Prof. Minchin is content to express the hostility of most zoologists, but he gives all the necessary material for following the discussion elsewhere. In summing up the affinities of the whole group he decides against the theory of Euglenoid ancestry which Bütschli advanced, and argues in favour of a descent from the Rhizopoda, quoting the interesting example of parasitism which Schewiakoff has found in simple amœboid forms. He concludes his article with a valuable compilation of sporozoan hosts, including Labbé's list with modern additions, and an abundant bibliography is appended, brought up to the beginning of the present year. It would be difficult to suggest any improvement in the author's selection of illustrations or in their execution.

Prof. Hickson, who has undertaken the Infusoria, does not include the Flagellata, but deals only with the Ciliata and Acinetaria, grouped as the Corticata Heterokaryota. Here again we can have nothing but praise for his admirably illustrated account of these

classes, and can only regret that it has been necessarily rather compressed. The limits of space have forced the author to deal briefly with the physiological inquiries for which the Ciliata have provided such a wonderfully fertile field. The work of Verworn and others upon the nuclear functions by means of "protozoan vivisection," and the studies of Miss Greenwood in intracellular digestion, are very shortly dealt with, while the classical accounts by Maupas of the processes of reproduction among the Ciliata deserve more expansive treatment than they receive in Prof. Hickson's excellent summary. Enough is given, however, of these biological studies to illustrate the author's discussion of the significance of the heterokaryote body, the individuality of the Infusoria after conjugation, and the incidence of somatic death among them, with which he prefaces his descriptive classification of the whole group.

The Foraminifera are dealt with in an article of the highest distinction by Mr. Lister, whose powers of lucid description, together with many original drawings and photographs of first-class merit, allow the reader to follow, perhaps for the first time with ease, the intricacies of skeletal structure and life-history found in this group. A unique value is given to this section by the inclusion within it of Mr. Lister's own researches into the remarkable phenomena of dimorphism in the Foraminifera, which he illustrates by a complete account of the alternation of the microspheric and megalospheric generations in the life-cycle of Polystomella. This dimorphism, with other characters, is followed through the various groups of Foraminifera so far as our present knowledge allows, and the facts are summed in a concluding survey, to which is appended a systematic classification and bibliography. Mr. Lister lays stress on the importance of life-history as evidence in the determination of phylogeny in this group, and this is becoming more and more evident in the case of other groups also of Protozoa. As an example of the questions of fundamental importance which are likely to arise in the further study of these life-histories may be noted the occurrence of the multiform condition especially in the microspheric generation, which Mr. Lister has ingeniously compared with the repetition of ancestral form seen in the sexually produced larva of the Cladoceran Leptodora, but not in its parthenogenetically developed young. This section marks a brilliant advance in description of the Foraminifera, and Mr. Lister is to be heartily congratulated upon it.

The earlier pages of the volume are given to an article by Prof. Farmer on the structure of animal and vegetable cells, of which, short as it is, nearly one-half is devoted to the discussion of reducing divisions and to some other physiological points. The problem of the structure of protoplasm and of the resting nucleus is dealt with, on the whole, perfunctorily, and is nowhere illuminated by reference to the results of Fischer and others in connection with the action of fixatives—results notably confirmed and extended in this country by Hardy—which already promise to remove these questions from the dust of a microscopists' quarrel and place it on the stage of exact physical inquiry.

PRACTICAL PHOTOGRAPHY.

Carbon Photography made Easy. By Thos. Illingworth. Pp. 150. (London: Iliffe and Sons, Ltd., 1903.) Price 1s. net.

Portraiture for Amateurs without a Studio. By Rev. F. C. Lambert, M.A. Part i. (Technical) and Part ii. (Pictorial). Pp. iv+176. (London: Hazell, Watson and Viney, Ltd., 1903.) Price, each part, 1s. net.

The Elementary Chemistry of Photographic Chemicals. By C. Sordes Ellis, F.I.C., F.C.S. Pp. 120. (London: Hazell, Watson and Viney, Ltd., 1903.) Price 1s. net.

Photography by Rule. By J. Sterry. Pp. 124. (London: Iliffe and Sons, Ltd., 1903.) Price 1s. net.

PHOTOGRAPHY as now practised may be regarded from so many points of view, and pursued for so many different purposes, that it is desirable to have treatises on special branches of it, such as those now under notice. A considerable advantage of this method of setting forth the facts and methods of photography is that each section may be dealt with by one who has paid special attention to it, and is able to speak upon it with authority.

Mr. Illingworth, for example, is a man whose business very largely consists in the making of carbon prints. His practical directions are, therefore, beyond criticism, and we put up with, without a murmur, his reference to "chloride, bromide, platinum, or other commoner printing processes" because of the frank and full way in which he describes the process in which he is a specialist. His book would have been better without the chapter devoted to the "Chemistry of the Carbon Process," for here he has gone outside his experience and his knowledge, and what he has set down tends to error and confusion. The discriminating student will discover this for himself, but beginners cannot always separate the wheat from the chaff, and it is for beginners that the book appears to be chiefly intended.

In a volume on the chemistry of photographic chemicals one looks for a special knowledge of the chemicals used in photography, but in the book before us there is not much evidence of this. The author appears to go out of his way to say that a "chemical change theory" of the developable image "is the one generally accepted at the present day." We very much doubt it. But in the matter that deals with the subject as set forth by the title, there are many statements that need modification, if not correction. Silver nitrate is doubtless the most important of all "photographic chemicals," but only little more than a dozen lines are devoted to its consideration. We are told that when prepared by dissolving silver in nitric acid hydrogen is evolved, and that when obtained in the solid form, preferably by fusion, it is not likely to be alkaline. Now fused silver nitrate often is alkaline, and as to the equation showing hydrogen liberated from nitric acid by the metal, the less said the better. We are told that the oxidation of sodium sulphite to sulphate by exposure to the air "is easily detected by the crystals becoming powdery and opaque,"

and that ammonia, when used as a follower to mercuric chloride in intensification, dissolves the silver chloride and forms ammonium dimercurous chloride, while sodium sulphite precipitates the mercury in the metallic form. The word "sensitisers" is applied to substances not usually so called, such as potassium bichromate. We are told that "when toning takes place with gold chloride, chlorine is given off." Of course it is not "given off" as that expression is commonly understood. Many other matters that need correction might be noted. Generally, methods of preparation are given, rather than the properties of the things as the photographer gets them. The latter is what is chiefly wanted, as photographers do not make their own chemicals, nor, indeed, are the instructions herein given generally a sufficient guide to enable them to do so.

Mr. Lambert, in his two small volumes on portraiture, writes from first to last from his own experience, and not only so, but in the greater number of cases demonstrates by examples the effects that he states result from certain procedures. The advantage of colour sensitised plates can be seen at a glance in the representation of the clothes, the hair, and the face or complexion of the sitter by inspecting the comparative examples given. The effects of different lenses, different positions of the camera, different methods of lighting, variations in exposure, different methods of dressing the hair and of posing the model, are all demonstrated. Indeed, it is hardly possible to think of any matter that bears upon the subject that is not dealt with and illustrated. The volumes are very suggestive to anyone interested in portraiture, and will be specially useful to the amateur who has no studio at his disposal.

Mr. Sterry has been a student of photography for a great many years, and has carefully followed, and often contributed to, the progress of the science that has taken place during the last decade or two. He is therefore specially fitted to treat of those methods of photography in which reasonable methods take the place of mere empiricism, and he has set down in a clear manner a summary of recent work so far as it affects the making of negatives and prints on bromide papers, including enlargements.

It seems to be necessary to make every book on photography a kind of manual for the beginner, and we suppose that Mr. Sterry has merely given way to the exigencies of the case when he explains what an "equivalent focus" is, and what is the size of a quarter plate. However, there are not many pages devoted to this sort of thing, and we judge that Mr. Sterry was heartily glad when he had done with them. Whatever beginners ought to do, they will not begin by photographing "by rule," and we doubt whether they can advantageously do so any more than they can well perform a quantitative exercise of any kind before they have got an idea as to how the action goes in a merely qualitative way. We intend it as a compliment to the volume and its author when we say that this book is not likely to appeal to the beginner.

We commend the courage of the author, and thoroughly agree with him when he says that hydroquinone and ferrous oxalate are the "least desirable" developers for general use. He admits, too, that different results may be obtained with the same exposures, by variations in development. Indeed, Mr. Sterry treats the subject in a fair manner, and cannot be accused of belonging to any particular "school." We cannot endorse his statement that the light intensities "between deep shadow and bright sky in an ordinary landscape have been conclusively shown to be less than 1 to 32," and his reference to the proof appears to be in error. The statement that the principal reason why negatives for enlargement should be thinner than for contact printing is the reflection of light from the surface of the paper and back to the paper from the surface of the negative in the latter case, is, we think, founded on a mistaken supposition. The difference appears to be due to the loss of the scattered light when the sensitive surface is not in direct contact with the negative. The author is mistaken in saying that the different methods of intensification give results that are "practically proportional throughout the scale." But remembering that the book is among the very first attempts that have been made systematically to describe the new methods of photography, it must be considered as notably successful, though we wish it had been rather more extended. "Rules" that have puzzled students for years are clearly explained, and effects that appeared to be erratic are shown to be the necessary results of the procedure.

OUR BOOK SHELF.

L'Evolution comparée des Sables. By Jules Girard, Membre de la Société de Géographie. Pp. iv+124. (Paris: Librairie scientifique et littéraire, F. R. de Rudeval, 1903.) Price 5 francs.

It is not clear whether this handsomely printed volume is addressed to the geological student or to the engineer. We presume, indeed, that its production has been a labour of love on the part of its author, who has brought together in a continuous form a number of facts recorded in French, German, and English publications. Here and there an original observation is introduced, like that on the deposit of angular blocks at Vauville (p. 8), which appears to present a problem akin to that of our Permian "breccias" on the coast of Devonshire. The photographs of types of sand-grains on pp. 10–13 have distinct value; in Fig. 8, however, radiolarians, though mentioned, are, to say the least, inconspicuous.

The erosion of the earth's surface by various agents is discussed, as explaining the origin of ordinary sands, and stress is properly laid on the atmospheric currents as agents of transport and accumulation of the fine material produced. Pp. 46–81 are, in fact, occupied by the subject of blown sands and dunes, and the various ways of arresting the invasion of fertile areas. The horse-shoe dunes figured on p. 70 are surely not so localised as the author suggests. They have been well discussed by Sokolów in a work translated into German in 1894, and appear, if we mistake not, in the memorable pages of Sven Hedin's "Across Asia."

The description of the changes undergone by coast-lines, especially in historic times, contains many interesting details. We miss, however, a comprehensive summary, such as would be useful to the geographer, showing how geological conditions and movements of the land have affected deposition along

the coasts. In this matter, modern American authors might have been called on. As it is, some such generalisation is promised on p. 112, but the volume ends abruptly nine pages later in the midst of local details of the Netherlands. M. Girard has certainly not allowed his subject to lead him into realms of speculation; on the other hand, his book lacks the system and arrangement which so often make a French work, even when its information is incomplete, seem like a well grouped picture in absolute harmony with its frame.

There are too many misprints in personal names throughout the book, the worst of which is "le baron de Reichtofen" on p. 55. "Scottisch" on p. 53 has also a quaint aspect. G. A. J. C.

Radium and other Radio-active Substances, with a Consideration of Phosphorescent and Fluorescent Substances. The Properties and Applications of Selenium and the Treatment of Disease by the Ultra-violet Light. By William J. Hammer. Pp. viii+72. (London: Sampson Low, Marston and Co., Ltd., 1903.) Price 5*s.* net.

MANY will probably be attracted by the first word of the title of this book, and buy it in the hope of obtaining light and leading on the new discoveries. Such, we fear, are likely to be sadly disappointed. The book is an apparently verbatim report of a lecture delivered at a meeting of the American Electrochemical Society and the Institute of Electrical Engineers. It is difficult to understand why it was reprinted in its present form, for most of the interest seems to have centred in the experiments and exhibits that accompanied the lecture. For example, we read, "Here are a couple of postal cards which I secured in Europe showing the Blue Grotto at Capri. They are printed with phosphorescent paints, and on exposing them to the light you will see that they are very pretty." Reproductions are provided of an elaborate "stage setting" to the lecture, of various tubes with the word radium written beneath, but which, so far as the reader is concerned, might as well have contained sugar, and of some photographs taken with the aid of radium. The latter, although of more general interest, are sometimes misleading. Thus Fig. 7 is a radiograph of glass lenses, and is used to throw doubt on the generally accepted fact that the radium rays cannot be reflected, refracted, or polarised, whereas it is obvious that the photograph is taken with ordinary light, either the phosphorescent light of the radium itself not being eliminated, or else by simple "fogging." With regard to the text, the part dealing with radium consists of the collection of a large number of facts collected together without discrimination or arrangement. Thus two pages are spent on Heydweiller's experiment on the loss of weight of radium, the opinions of various eminent authorities with regard to this experiment are quoted as obtained by the author, and at the end we learn that the observation in question has been admitted by the observer to have been the result of an accident. Snippets of information are provided from most of the important researches which would be quite unintelligible to those not intimately acquainted with the subject and superfluous to those who are.

The Experiment Station Record. Vol. xiv. Nos. 5–9. (Washington: the United States Department of Agriculture, 1903.)

THE "Experiment Station Record" consists in chief of a series of abstracts of papers dealing with agricultural science all the world over, together with occasional general reviews and summaries. Abstracts are very rarely wholly satisfactory to the scientific worker, but there are few subjects more in need of work of this kind than is agriculture. The recognised organs of agricultural science are numerous enough, but much valuable work escapes their notice and appears in the irregularly issued reports and bulletins of some State or institution or society, or, again, is published in a journal devoted to one of the many pure sciences on which agriculture touches. Hence the value of the "Experiment Station Record"; so thorough is the organisation of the United States Department that very little escapes its net, and the student with an intelligent capacity for reading between the lines will by its help be generally put on the track of anything which concerns him specially. Particularly he will be saved the trouble of looking through the very numerous annual reports and bulletins issued by the separate States in America, for they are fully reported in the "Record," and almost wholly neglected by the German abstractors. We believe our own Board of Agriculture is about to undertake a somewhat similar work for the many scattered publications of county councils and colleges which have been doing agricultural experiments in this country during the last ten years or so. We doubt if the "Experiment Station Record" is as well known as it deserves to be; at any rate, several of our best specialist libraries in London possess it very partially, if at all, useful as it is even to men engaged in pure science. Meantime, it has become indispensable to all workers in agricultural science, and they owe a debt of gratitude to the United States Department of Agriculture both for its publication and for the liberality with which it is distributed.

A. D. H.

Jahrbuch der Chemie. Twelfth Year, 1902. Edited by R. Meyer. Pp. xii+544; and General Register to same, i.–x., 1891–1900. (Brunswick: Vieweg und Sohn, 1903.) Price 15*s.* and 11*s.*

MEYER'S "Jahrbuch" is too well known among chemists to require description. It aims at giving a summary or review of the chief chemical contributions of the year. When one considers that in this comparatively short period upwards of 6000 researches (the number is taken from the *Centralblatt*, and does not include patent literature) find their way into print, the process of selection becomes a very arduous one, requiring on the part of the different collaborators—experts in their several provinces—not only much reading, but careful discrimination.

This large mass of material seems on the whole to be well sifted, but the condensed form in which it is presented robs the book of any literary merit, and gives it the indigestible and fragmentary character of a dictionary. English chemical literature scarcely receives full justice, not that the proportion of references is small (out of 160 papers published by the Chemical Society 28 are referred to), but these, it will be generally admitted, do not in all cases represent the most valuable English researches of the year.

The general index for the first decade is published with the "Jahrbuch," and as a book of reference should be useful. J. B. C.

Flowering Plants: their Structure and Habitat. By Charlotte L. Laurie. Pp. x + 157; with illustrations by W. L. Boys-Smith. (London: Allman and Son, Ltd., n.d.) Price 2*s.* 6*d.*

THIS little book is intended for students who have already studied the elementary principles of botanical science. It is divided into three parts, dealing with respectively, the most general conclusions of ecology relating to the habitat of plants, the minute structure of the plant and its adaptations to its habitat, and certain natural orders, regarded more particularly from the point of view of their ecological characteristics. The treatment is simple, though brief, and the illustrations are unusually good.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Heating Effect of the Radium Emanation.

IN connection with the discovery of P. Curie and Laborde that radium continuously emits heat at a rapid rate, an interesting question arises as to whether the heat emission is directly connected with the radio-activity of that element or is independent of it.

To settle this point we have performed the following experiments. The heating effect of 30 milligrammes of pure radium bromide was first measured in a differential air calorimeter. The radium bromide was then heated to a sufficient temperature to drive off the emanation, and the latter was condensed by passing through a short glass tube immersed in liquid air, and then the tubes were sealed off. On testing the de-emanated radium, the heating effect diminished rapidly during the first few hours, and fell to a minimum corresponding to about 30 per cent. of the original value and then slowly increased again. On substituting the emanation tube in the calorimeter, the heating effect at first increased for a few hours to a maximum corresponding to about 70 per cent. of the original heat emission of the radium and then slowly decayed with the time.

At any time after removal of the emanation, the sum of the heating effect of the de-emanated radium and of the emanation was found to be the same as that of the original radium. Experiments are still in progress to determine the rate of recovery and loss of heating power of the de-emanated radium and the separated emanation respectively, but so far as the observations have gone, the curves of decay and recovery are the same as those for the corresponding α radiation.

It has been shown (Rutherford and Soddy, *Phil. Mag.*, May) that, if the emanation is removed from radium, the activity of the radium decays in the course of a few hours to about 25 per cent. of its original value. This residual activity consists *entirely* of α rays. The solid radium compound regains its original activity after the lapse of about one month. Immediately after the separation of the emanation the activity (tested in a sealed vessel) rises to about twice its original value, due to the production of excited activity on the walls of the vessel, and then slowly decays with the time, falling to half value in about four days. At any time after removal of the emanation the sum total of the activity of the radium and the emanation has a value equal to that of the original radium.

There is thus an exact parallel between the variation in radiating power (measured by the α rays) and the heating effect. In order to be sure how much of the emanation was removed by heating, control experiments were made on the γ rays from the radium and the separated emanation. This was tested by observing the rate of discharge of an electroscope after the rays had passed through 5 cm. of lead. In some preliminary experiments by one of us last year it was found that the γ rays from radium appeared at the same time as β rays, and were always proportional to them. From these results it was deduced that all but 6 per cent. of the emanation was removed by the heating.

It is thus seen that the heating effect of radium *directly accompanies* the α radiation from it, and is always proportional to it, and that more than two-thirds of the heating effect is not due to the radium at all, but to the radio-active emanation which it produces from itself. This result accounts for the variation of heat emission with age observed by the Curies, an account of which was given by Prof. Dewar at the British Association.

The amount of emanation from 30 milligrammes of radium bromide, when collected in the tube, was sufficient to cause a bright phosphorescence in the tube, but it was too small either to measure or weigh. The amount of heat emitted from the radium emanation is thus enormous compared with the amount of matter involved. It seems probable that the greater part of the heating effect of radium is a direct consequence of the expulsion of α rays. It still remains to be shown in what proportion the radiated energy is distributed between the projected α particles and the systems from which they are expelled.

The results given here are at once explained on the disintegration hypothesis (Rutherford and Soddy, *Phil. Mag.*, May), in which the heat is considered to be derived from the internal energy of the atom. On the view held by some that radium gains its heat from an external source, it would be necessary to suppose that less than a third of the heat is due to the radium itself, and that the other two-thirds are due to the radium emanation which is being continuously produced, and the power of which of absorbing energy from an external source decays with the time.

E. RUTHERFORD.
H. T. BARNES.

McGill University, Montreal, October 16.

Papers and Procedure at the British Association.

AT the recent meeting of the British Association at Southport I heard numerous complaints (repetitions of those I have heard at not a few previous meetings) by the general public, members of the Association, on the too technical character of the papers read before it. These complaints referred to all the sections except, perhaps, those of anthropology, geography, and educational science. One overheard too often to be pleasant such remarks as "I am interested in zoology, but what is the good of coming to listen to such a paper as this? I have no idea what the speaker is talking about"—the paper, in one specific instance, was cytological, and of great value undoubtedly; and, "I have not gained much by becoming a member of the Association; the papers are all over my head." These complaints are being made by well educated men and women interested in science, but not versed in its technicalities.

Believing that this feeling in reference to the subjects brought before the various sections is growing, and is, moreover, not ill-founded, I venture, as a member of twenty years' standing, to direct serious attention through your columns to its existence, and to advocate some change in the character of the papers accepted for reading before the Association, so that the objects for which this great society was founded may be more fully attained as regards the general public of the town visited, on the support of which the Association is so largely dependent.

Purely technical papers which appeal only to the specialist in chemistry, biology, engineering, or physics, are out of place before an audience the majority of whom are not specialists, but who have become members for the occasion in the hope of listening to an understandable exposition of the subject by the men who have contributed to making that section of science. Such purely technical papers should be reserved for the societies which exist for the cultivation of that particular subject. The British Association should either become a purely scientific society or become more what it was established for, an association for the advancement of science among the people, at which the *results* of the investigations of the year are, as it were, summed up and presented to the members, both specialists and those of the general public interested in science, in language which the whole audience can understand. An author, instead of going into the details of the various intricate investigations and experiments he has made—which can often enough be followed fully only by his fellow-workers in that particular section of his subject—should far more than heretofore deal broadly with the results obtained, indicating their value to the particular subject, and their bearing on his own or other departments of knowledge. The general public have really some cause for complaint that their subscription has been obtained from them on a misunderstanding. If the Association is to become more and more a purely scientific society, then the fact should be made more widely known, so that disappointment may not be needlessly caused to those who join it. In that case, moreover, there would be no need of the publicity with which the Association meets at the various towns it visits. It might quietly assemble at the chosen town in rooms hired or lent for the purpose, and associate itself only with the specialists of the place.

Liverpool, October 20. HENRY O. FORBES.

A Little-known Peculiarity of the Hamadryad Snake.

A STRUCTURAL peculiarity of the "king cobra" which I have recently ascertained while studying the anatomy of the Ophidia seems to me to be so remarkable that it must have been noticed in such comprehensive works as Bronn's "Thierreich" and Dr. Gadow's account of serpents in the "Cambridge Natural History" were it known. I venture, therefore, to give a short account of the matter without professing to have made an exhaustive survey of the literature of the group. The windpipe of this snake opens, as usual, not far from the heart into the lung, which presents no remarkable divergencies from the lungs of other snakes; it is in the same way functional as a lung for the first half, and becomes a mere thin-walled air bag posteriorly. Before opening into the lung, however, the trachea is connected with a long series of approximately equi-sized air sacs in the neck, which follow close upon each other, and entirely occupy the neck down to the region where the heart lies. These sacs are so closely adpressed that the appearance given is that of a series of septa, dividing the space surrounding the windpipe and gullet into metamerically arranged compartments. I thought at first, in fact, that I had been able to observe a segmentation of the cœlom in this region quite analogous to that of an annelid. Each cavity, however, is continuous with the interior of the windpipe by an oval and clearly defined orifice on its lower surface. These apertures are regular and of fairly equal size, and give to the windpipe quite the appearance of a flute. There are a large number of them, thirty to forty. There is no question here of pathological conditions or of accidental cuts. The regularly disposed series of sacs into which they open negatives anything of the kind. They are, I suppose, an extreme modification of what the late Prof. Cope termed the "tracheal lung" in Chersydrus and other snakes. The most obviously comparable structure that I can think of for the moment is the ventral slit in the windpipe of the emu, which similarly opens into a thin-walled sac. This is believed to be connected with the singular "drumming" sound emitted by that bird. Perhaps some of your readers who are acquainted with the Hamadryad can inform me as to a possible "voice," or whether it can produce a varied or especially prolonged hiss. I propose to offer a more detailed account of the structure of the windpipe and other organs of this snake to the Zoological Society as soon as possible. FRANK E. BEDDARD.

The New Bishop's Ring.

REGARDING M. Forel's suggestion (see NATURE, p. 396) that persons ascending to considerable altitudes should observe whether the ring around the sun, which was so noticeable a phenomenon after the diffusion of the volcanic dust from the Krakatoa eruption in 1883, is again visible, I beg to say that, before reading his letter in *La Gazette de Lausanne*, I had noted the ring on August 20 from the Montanvert, near Chamonix, at an altitude of 6300 feet. The day was exceptionally clear, and when a peak hid the sun itself, the whitish glare fringed with reddish brown that surrounded it attracted my attention. Being upon the summit of Mont Blanc (15,780 feet) on September 1, in clear weather, I again observed the ring, which, however, was no better defined than lower down on the mountain, notwithstanding the circumstance that the dark blue sky furnished an excellent background. Angular measurements there showed that the radius of the visible outer limit of the reddish ring was between 20° and 25°.

While the phenomenon was not again seen by me last summer in Europe, it has often been observed during the past year here at my observatory, elevated only 640 feet above the sea, and an article in *Science* of January 23 by my assistant, Mr. Clayton, describes the reappearance of this second "Bishop's ring" and the accompanying brilliant sunsets during the early part of last winter. Subsequently, the ring was observed in January and February, and also in May, June, and July, when highly coloured and prolonged afterglows followed the sunsets towards the close of the latter month. During the first part of August the ring was seen on clear days, and during September the vivid yellow colour of the western sky, persisting sometimes more than an hour after sunset, was frequently recorded. To-day (October 14), after a period of rainy weather, the ring is distinct, and measurements made here some time ago gave 26° as the radius of the whitish haze and 5° more for the reddish border, indicating that its visible extension was greater even than on Mont Blanc.

M. Forel states that he has seen a coloured circle surrounding the sun since the first of last August. The fact of it not having attracted notice previously in Europe would seem to show either that the clearer atmosphere of the United States favours its perception, or that the microscopic dust in the upper air, which is supposed to produce the diffraction phenomenon, preponderates above this country. The last hypothesis is supported by the fact that, from the proximity of the West Indian volcanoes, the fine dust ejected by them during the eruptions that year may have drifted northward, before making a circuit of the globe, and a larger quantity may still remain suspended in the rarefied atmosphere above the eastern United States than exists over Europe. A. LAWRENCE ROTCH.

Blue Hill Meteorological Observatory, Massachusetts, U.S.A., October 14.

The Nervous System of Anodonta cygnea.

THE supra-œsophageal ganglion of Anodonta is usually regarded as representing both the cerebral and pleural ganglia, and is commonly spoken of as the "cerebro-pleural." Prof. Howes mentions in his "Atlas" that Prof. M. Hartog has occasionally observed a ganglionic swelling on one or both of the cerebro-visceral connectives in front of the pericardium, but that he himself has failed to find any such enlargement. In view of the doubt that exists, it seems to be worth recording that yesterday one of my pupils, A. C. Roxburgh, while dissecting an Anodonta in the Charterhouse laboratory, exposed a well-developed ganglion of the usual orange colour, upon the left connective in the exact position mentioned by Prof. Hartog. Microscopical examination removed all doubt as to the nature of the swelling. for numerous ganglion-cells were easily recognised in the teased preparation. It is thus probably more correct to term the anterior ganglion "cerebral" rather than cerebro-pleural. Perhaps some of those who are better equipped for research than is possible or advisable for those engaged in elementary laboratories might find it worth while to examine series of sections of the connective at this region. It is possible that the pleural ganglion may in most cases be represented by but a few ganglion cells the presence of which is not discernible to the unaided eye.

May I, as I am writing about this animal, direct attention to an error that is universal in text-books? The muscles always spoken of as retractors and protractor of the *foot* have not the function that their titles imply. The protrusion of the foot is due to vascular turgescence, and its withdrawal to relief of the turgid condition and contraction of the intrinsic pedal muscle fibres. *The muscles in question move the shell, the foot being the fixed point.* Thus the so-called anterior and posterior retractors of the foot should be styled the *protractors of the shell*, and the protractor of the foot the *retractor of the shell*. I may mention that I have often seen Anodonta go backwards when its deliberate movements have led it into a *cul-de-sac* in the aquarium. OSWALD H. LATTER.

Charterhouse, Godalming, October 24.

LORD KELVIN AND HIS FIRST TEACHER IN NATURAL PHILOSOPHY.

SOME interesting early recollections were related by Lord Kelvin on October 17, on the occasion of the unveiling of a stained glass window, by Henry Holiday, in the Bute Hall of the University of Glasgow in memory of John Pringle Nichol, LL.D., professor of astronomy, 1836–1859, and his son and daughter, John Nichol, LL.D., professor of English language and literature, 1862–1889, and Mrs. Jack, who was born in 1837, in the University, and died there in 1901. Prof. J. P. Nichol was the author of numerous valuable works, including the famous book on the "Architecture of the Heavens." The account which Lord Kelvin gave of his own young days at

Glasgow College is full of interest, and his testimony to the impulse he received from his early teacher will be an enduring tribute to Nichol's memory.

In the course of his remarks, Lord Kelvin said:—Principal Story, You recall to my mind the happy days of long past years, 1836, when John Pringle Nichol came to be professor of astronomy in the University of Glasgow. From the time he first came among us—I say among us, because I, as a child, was not then a member of the university, but an inhabitant of the university—when Dr. Nichol, as we then called him, came among us, he became a friend of my father, and that friendship lasted to the end of my father's life. I may also claim that I became a student of Dr. Nichol's from the time he first came to Glasgow. Year after year passed, and I still remember his inspiring influence. The work on which I am engaged at this day is work to which I was initiated in the years 1837, 1838, and 1839, when I was a child. The summer of 1840 is for me a memorable summer, a year of brightness in my memory. I had been for one session a student in the natural philosophy class of the university conducted by Dr. Nichol. From beginning to end, with the exception of a few days, when my predecessor, Dr. Meikleham, began the course which he could not continue on account of his health, the class of natural philosophy, in the session 1839–40, was taught by Dr. Nichol. He came on short notice to occupy the post, and he did it in a most admirable manner. I lately had the opportunity allowed me by my friend and colleague, Prof. Jack, to see a manuscript book of John Pringle Nichol's, a book of exercises and preparations for the natural philosophy class. I was greatly struck with it, and much interested to see in black and white the preparations he made for the splendid course of natural philosophy that he put us through during the session 1839–40. In his lectures the creative imagination of the poet impressed youthful minds in a way that no amount of learning, no amount of mathematical skill alone, no amount of knowledge in science, could possibly have produced. For, many years afterwards, one of the most important affairs I have ever had to do with began with what I learned in the natural philosophy class in that session. I remember the enthusiastic and glowing terms in which our professor and teacher spoke of Fourier, the great French creative mathematician who founded the mathematical theory of the conduction of heat. I was perfectly astonished. I remember how my youthful imagination was fired with what I heard from our teacher. I asked him, "Do you think I could read it?" He said, "The mathematics is very difficult." At the end of the session I got hold of the book ("Théorie analytique de la Chaleur") out of the university library, and in the first half of the month of May, 1840, I had, I will not say read through the book, I had turned over all the pages of it. Then we started out from Glasgow for Germany, the joint families of my father, my brothers and sisters, and our friend Dr. Nichol and Mrs. Nichol, and John Nichol and Agnes Jane Nichol. The two families made together a tour in Germany, and during two months or six weeks in Frankfort, Mrs. Nichol and her two children were with my father and his family every day while their father went on tour to the Tyrol. Excuse me for speaking of those old times. I am afraid I have trespassed on your patience. These recollections may be nothing to you, although they are dear to me. They are, indeed, closely connected with the subject of the present meeting.

While we were encamped for a time in Bonn, Dr. Nichol took me and my elder brother on a walking tour in the volcanic region of the Eifel. We had four days of intense enjoyment, and the benefit of what we learned from him, and saw around us, in that interesting region remained with my brother all his life, and remains with me.

I have to thank what I heard in the natural philosophy class for all I did in connection with submarine cables. The knowledge of Fourier was my start in the theory of signalling through submarine cables, which occupied a large part of my after life. The inspiring character of Dr. Nichol's personality and his bright enthusiasm lives still in my mental picture of those old days.

The old astronomical observatory—the Macfarlane Observatory—was situated in the upper part of the old college green, or garden, as we used to call it, behind the college, off the High Street. I do not suppose any person here ever saw the old college green, but you have all read of it in "Rob Roy," and of the duel between Osbaldistone and Rashleigh. I do not remember the details of the duel, but I remember it was appointed to be fought in the upper part (at least I have always assumed, in my mind, it was in the upper part) of the college garden of the University of Glasgow. The garden was in two parts, the lower on the near side of the Molendinar, the upper on the higher ground beyond the stream, which we crossed by a bridge. Has any person here ever seen the Molendinar? There used to be mills on it, I assume, from the name. It is now a drain! Before we left the old college it was covered in. We had still the upper and lower green, but the Molendinar flowed unseen for many years after the university left the old site. I remember in the Macfarlane Observatory beautiful experiments on light shown us in the most delightful way by Dr. Nichol, Grimaldi's fringes by sunlight, and prisms showing us splendid solar spectra, and telescopes, and brilliant colours on a white screen produced by the passage of polarised light through crystals. He gave us firmly the wave theory of light, and introduced us to Fresnel's work. As he appreciated Fourier, so he appreciated Fresnel, two of the greatest geniuses in science, and fired the young imagination with the beautiful discoveries of those men. In that old observatory in the high green, and in the natural philosophy class-room of the old Glasgow college, was given to me the beginning of the fundamental knowledge that I am most thoroughly occupied with to this very day, and I am forcibly obliged to remember where and when my mind was first drawn to that work which is a pleasure to me, and a business to me just now, and will, I hope, be so for as long as I have time to work. You can imagine with how much gratitude I look upon John Pringle Nichol and upon his friendship with my father. His appointment as professor of astronomy conferred benefit, not only upon the University of Glasgow, but also upon the city and upon Edinburgh, and the far wider regions of the world, where his lectures were given and his books read. The benefit we had from coming under his inspiring influence, that creative influence, that creative imagination, that power which makes structures of splendour and beauty out of the material of bare dry knowledge, cannot be overestimated.

FLOW OF STEAM FROM NOZZLES.

It is well known that when a gas is flowing from a vessel by an orifice, if the outside pressure is less than sp_0, p_0 being the pressure in the vessel where the gas is at rest, the pressure in the throat of the orifice is never less than sp_0 if s is

$$\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}$$

where γ is the ratio of the specific heats. s is 0·527 for air. It is also known that, with fair accuracy, we

may assume steam which is dry and just saturated to behave as if it were a gas the γ of which is 1.13, and steam with 25 per cent. of moisture as if it were a gas the γ of which is 1.113. It results that the velocity in the throat delivering steam is never greater than the velocity of sound in such steam as exists in the throat, and the pressure in the throat is never less than 58 per cent. of the pressure inside the vessel, however low the pressure of the outside space may be.

Mr. Napier's experiments first directed attention to this phenomenon, and Prof. Osborne Reynolds, in 1885 ("Collected Papers," vol. ii. p. 311), gave the explanation.

Students are still too much influenced by their knowledge of flowing water; they cannot help thinking that the flow of a gas is analogous, whereas in all important particulars the flow of a gas is entirely different from the flow of a liquid. After much unbelief among students of this subject, it is now becoming known that when there is a divergent mouthpiece outside the throat, the velocity of a compressible fluid may become very much greater than the velocity of sound; speeds of 3000 or 4000 feet per second seem to be possible at the ends of the divergent orifices used in the Laval turbine. Some years ago I framed a theory of the injector which seemed reasonable, and yet I found it wrong in its application to experimental results. I now know that it was really a good working theory. It seemed to be wrong really because I could not imagine a velocity of steam greater than that found by Napier, the velocity of sound.

I wish to show that the reasoning of Prof. Osborne Reynolds leads to an explanation of what occurs in an expanding mouthpiece. The motion is steady in the vessel until the narrowest part or throat is reached; in the expanding mouthpiece the motion is turbulent, but perhaps I may be allowed to consider the motion as steady throughout, as this will illustrate what occurs well enough, and turbulent motion mathematics is quite beyond my powers.

If W is the weight of gas passing along a stream tube the cross section of which is A, then at a place where the pressure is p we know from the usual reasoning that

$$W = A\sqrt{\frac{2g\gamma}{\gamma-1} w_0 p_0 \left(\alpha^{2/\gamma} - \alpha^{1+1/\gamma}\right)} = Awv$$

if w is the weight of unit volume of the gas, being w_0 where p is p_0 and if α stands for p/p_0.

Now let us keep W constant, and we are able to calculate the cross section of the stream at any place where p is known.

I sometimes ask the individuals of a class of students to calculate, each of them, a part of such a table as the following:—

Imagine steam in a vessel at $p_0 = 14400$, or 100 lb. per square inch, to flow towards a throat with an expanding orifice outside; at the following pressures I give the corresponding cross sections A of a stream tube and the velocity there. It will be seen that where the tube is narrowest the pressure is 57.85 lb. per square inch; this is near the narrowest part of the orifice. Beyond this in the expanding part A increases, the pressure falls, and the velocity becomes greater and greater.

I take a stream tube in which the flow is 1 lb. per second, or W = 1. These numbers deserve study. It is evident that to get very high speeds the mouthpiece must be much enlarged from the throat, but as rapid enlargement must lead to greater turbulence, velocities much greater than 3000 feet per second ought hardly to be expected.

If we double all the pressures in the table, the values of A and v there given are right for the case of flow of steam from a vessel where p_0 is 200 lb. per square inch; about two pounds of steam per second now flows along the tube.

An expanding mouthpiece increases the flow of water, and velocities are less where cross sections are greater; but in the case of air or steam, the total quantity flowing is not increased, and velocities are greater where cross sections are greater.

p lb. per sq. in.	A sq. ft.	v ft. per sec.	p lb. per sq. in.	A. sq. ft.	v ft. per sec.
100	∞	0	40	0·00524	1963
90	0·00732	658	30	0·00599	2252
80	0·00541	994	20	0·00743	2654
70	0·00489	1245	15	0·00889	2910
60	0·00483	1456	10	0·01170	3220
57·85	0·00481	1512	5	0·01430	3506
55	0·00484	1573	2½	0·03306	4214
50	0·00488	1708			

JOHN PERRY.

PROGRESS OF GEOLOGICAL SURVEY OF THE UNITED KINGDOM.

IT would be impossible to give on one page an epitome of the work done in a year by the Geological Survey, but it may be possible to explain the arrangement of the official summary of progress and to indicate the character and range of the information contained in it.

By far the greater number of persons who consult it want first of all to learn whether anything new has been published about their own district. We find, therefore, that the information is arranged geographically under the heads England and Wales, Scotland and Ireland, and that subordinate to these there is a reference to districts, not well defined physical or political divisions of permanent importance, but divisions arbitrarily chosen for the purpose of easy reference to the areas over which the work of the year has been carried on.

The descriptions are further classified under the names of the geological formations found in each district.

The most important part of the work deals, of course, with the observations made in the field and recorded on the maps and sections, or described in memoirs and explanations, but the palæontological, petrological and chemical work all receive special notice, as do the products of economic value and the excellent museum connected with, and largely brought together by, the Survey.

All who are engaged in geological teaching or research, or the practical application of the science, must watch the results obtained by the Survey, whether they involve, as proved by Mr. Thomas, a correction of the section across the Towy Valley, or throw light on the relation of the Devonian to the Old Red, as may be seen in Mr. Strahan's work, or furnish material for determining the exact "geological equivalents" of the coal-bearing strata in several distinct and isolated areas, as shown by Mr. Kidston, or data for discussing with Mr. Clement Reid the conditions which prevailed when the deposits were laid down in which man's remains first appear.

The practical man, who has always met with so much courtesy and assistance in the Survey Office, whether he seeks how he may find water or in which direction he might hope to pick up again a lost seam of coal or vein of metal, has always turned to the publications of the Survey for the results of the latest and most careful examination of the district in which he is interested.

It is, however, difficult for a man of small leisure to search through the maps, sections, explanations, and memoirs to see whether there is anything which immediately concerns him. In the annual report of progress such men find a short account of what has been done and often a forecast of what line of research it is proposed to follow next—as, for example, in the description of the coal-bearing strata in the basin of the Amman.

It would, however, be a mistake to suppose that the results achieved are of interest to geologists only. From the summary of progress just issued, it may be seen that the work appeals to a much wider public than would at first appear. It contains a record of accurate observations on the relation to one another of the great masses of which the earth's crust is made up—very different from the *a priori* reasoning as to how they ought to behave with which we have so often had to be content. If we turn to the very first page of the introduction, in which the able director of the Survey gives a sketch of what he and his men have done, we read that they have demonstrated that the arrangement of the different kinds of rock proves that there have been movements by which slices of sedimentary and igneous matter, of heavy basic and lighter acidic rock, have been thrust in, so that they now appear in alternating layers over large areas, and further that these earth movements have crushed and kneaded and drawn out the constituents of the rock so that its structure is quite different from that which they have reason to infer it once had from the changes observed as they trace each mass across the country.

The physicist and astronomer will find in the survey publications the results of observations on earth movements recorded by a man like Mr. Harker, who is not only one of the highest authorities in petrography, but also a mathematician of the first order; while geographers will note with interest the inferences which are forced upon clear-headed and experienced observers like Mr. Strahan, who are trained, as few ordinary travellers are, to watch every indication of change of rock structure, and to trace the guiding influence of systems of displacement upon the rivers and other denuding agents which have moulded the surface of the land.

In the Survey memoirs biologists will find treatises, by men like Woodward, Clement Reid, and Lamplugh, dealing with ancient climatal and physical conditions which have varied, as inferred from the flora and fauna as well as from other indications, with the great geologic changes of the earth's crust.

On the staff of the Survey are many men of world-wide reputation who are approaching these large questions from many different points of view, and fully realise what large superstructures may be built up on the facts which they lay down. Carping critics talk of the "uncertainties of geology"; that is because the public is sometimes told what working hypothesis is suggested by evidence which is known to be incomplete. It is not necessary for pioneers to be always repeating the *certainties*, and the Summary of Progress lets the public follow the work as it is going on.

NOTES.

THE council of the Royal Meteorological Society has awarded the Symons gold medal to Prof. Julius Hann, of Vienna, in recognition of the valuable work which he has done in connection with meteorological science. The medal will be presented at the annual meeting of the Society on January 20, 1904.

A bust of John Dalton, presented to the Manchester Literary and Philosophical Society by Sir Henry E. Roscoe on the occasion of the centenary of the announcement of the atomic theory, was unveiled on October 20. The secretary read the following letter from Sir Henry Roscoe:—"I desire to present to the Literary and Philosophical Society of Manchester a bronze bust of Dr. Dalton, as a memento of the many years of pleasant intercourse which I have in past days spent in converse with its members, and as a recognition of the honour which the Society has done me by electing me as an honorary member, and in bestowing upon me its Dalton Medal. The bust is the work of a distinguished sculptress, Miss Levick, and I believe that all those who have seen it agree with me in esteeming it a powerful and lifelike work of art. It will give me great satisfaction to hear that the Society accept my gift, and that they value the bust as a work of art and as a reminiscence of the donor." The president, in formally unveiling the bust, observed that it was a happy coincidence that this meeting took place on the anniversary of the date when Dalton communicated to the Society his paper on the absorption of gases by water, in which was given the first hint of the atomic theory.

THE zebra stallion Matopo, which has been described and figured by Prof. Cossar Ewart in his book "The Penycuik Experiments," and was the sire of some interesting zebra-horse hybrids, is dead. This zebra was purchased some time ago by Mr. Assheton-Smith, Vaynol Park, Bangor, who was hopeful that he might find it possible to repeat some of Prof. Ewart's experiments, but unfortunately his expectations have not been realised. Whilst retaining the skin, he has presented the skeleton of the zebra to the University College of North Wales, where it will form a handsome addition to the zoological collection. It may also be noted that to this college Prof. W. A. Herdman, F.R.S., of Liverpool, recently made a donation of some fishes from Ceylon and Indo-Malaya which he collected when in the East investigating the pearl fisheries of Ceylon. Prof. D'Arcy Thompson, C.B., Dundee, has also presented a skeleton of the somewhat rare sea otter (Enhydra) from Alaska. By presentation and purchase a valuable zoological collection, which is under the care of Prof. Philip J. White, has gradually been formed at the college.

DR. DAWSON TURNER has been awarded a Keith prize by the Royal Scottish Society of Arts for papers upon improved Röntgen apparatus and other electrical matters.

AT an auction sale of rare, valuable and standard books by Messrs. Hodgson and Co., Chancery Lane, on October 21, a complete set of Curtis's *Botanical Magazine*, from the commencement in 1787 to the present month, realised the sum of 120*l*.

THE opening meeting of the Institution of Electrical Engineers will be held on November 12, when the premiums awarded for papers read or published during the session 1902–1903 will be presented, and the president, Mr. Robert Kaye Gray, will deliver his inaugural address.

MR. MARCONI, in company with Captain H. B. Jackson, has gone to Gibraltar to carry out further experiments for the Admiralty. It is hoped to be able to open communication with Gibraltar before losing touch with Portsmouth.

ACCORDING to the daily papers, the Post Office authorities are about to make experiments with the de Forest system of wireless telegraphy. Dr. Lee de Forest has come over

from America to superintend the experiments; the system, in which an electrolytic conductor is used in place of the ordinary coherer, is in considerable use in America.

A FORTNIGHT ago we were able to record the fact that a speed of 125½ miles an hour had been attained by the Siemens car in the high-speed trials which are being carried on at Berlin. Last Friday this record was beaten, and a speed of 130½ miles an hour attained. It is said that a higher speed than this is not desired. The passing of the car at full speed seems to have created a strong impression on a large crowd of sightseers who witnessed the experiments from Dahlwitz Station.

WE regret to see the announcement of the death of Dr. C. T. Hudson, F.R.S., president of the Royal Microscopical Society from 1888 to 1890, and joint author of Hudson and Gosse's "Rotifera." Dr. Hudson was born in 1828, and was fifteenth wrangler in the mathematical tripos of 1852. From 1855 to 1860 he was headmaster of Bristol Grammar School, and from 1861 to 1881 of Manilla Hall, Clifton. He was elected a fellow of the Royal Society in 1889, chiefly on account of his work on Rotifers, concerning which he was the chief authority. The genus Pedalion, discovered and described by him, was a very remarkable and important contribution to animal morphology; Dr. Hudson was also the discoverer of numerous other new genera and species of Rotifera, described in the publications of various scientific societies.

AN announcement is made in a Government resolution on the annual report of the Survey of India for 1901–2 that the necessity for effectively revising and keeping up to date the maps now in existence, as well as of providing fresh ones, has been forced upon the Government of India. "We can only hope," says the *Pioneer Mail*, "that there may be no half measures, and that the reform may be thorough, for assuredly the need is more crying than most can have any idea of."

ACCORDING to the *Westminster Gazette*, Mr. F. du Cane Godman has recently presented to the British Museum (of which he is a trustee) a collection of nearly 30,000 specimens of beetles, following on a previous donation of 50,000. The present collection consists mainly of representatives of the family Elateridæ, or "ship-jacks," the bulk being from Central America. The collection in the Museum is now the finest in the world, and housing space is a problem. Our contemporary makes a curious mistake in referring to the fact that 150,000 *specimens* of beetles are already described, and that the annual addition to the British Museum collection averages 400 *specimens*; in both cases, of course, *species* are meant.

A REUTER telegram from Wellington, dated October 25, states that the Antarctic relief ship *Morning* has left Lyttelton to join the *Terra Nova*, the relief ship for the *Discovery*, at Hobart. In connection with the relief of the Nordenskiöld Antarctic Expedition, the *Times* reports that the Swedish vessel *Frithjof*, the French steamer *Le Français*, and the Argentine gunboat *Uruguay* will meet at Ushnaia on November 1, and will then proceed to Seymour's Island, and from thence to Snowhill, Dr. Nordenskiöld's proposed base.

A CORRESPONDENT, referring to Prof. W. H. Everett's letter on rocket lightning in our last issue, directs attention to a closely similar phenomenon observed in London between 2 and 3 a.m. on the morning of October 16. From the south-eastern horizon of a clear sky, a "wriggling stream" of bluish-white light shot up in a vertical direction and broke off short without spreading. It would be interesting to know if any other observer witnessed this display, and if a thunderstorm occurred that night anywhere to the south-east of London within twenty or thirty miles.

COMMANDER R. E. PEARY has been granted leave of absence in order to make one more attempt to reach the North Pole. In a letter to the Secretary of the U.S. Navy, published in the *National Geographic Magazine* for this month, Mr. Peary outlines the plan he proposes to adopt. He intends to make his winter camp fully one hundred miles north of his previous winter quarters, so that when he is ready to start in spring he will be a hundred miles nearer his goal. The distance from Peary's proposed winter camp near Cape Joseph Henry to the North Pole and back again is less than the average distance of four sledging trips which he has made. Mr. Peary proposes to start in July, 1904, to reach Cape Joseph Henry with his vessel in the fall of that year, and to make his dash for the Pole in 1905. In case he does not reach the proposed winter camp in 1904, he will spend 1905 in reaching it, and attempt to reach the North Pole in 1906.

THE fourteenth International Congress of Americanists will be held at Stuttgart on August 18–23, 1904, under the presidency of Prof. Karl von den Steinen. The congress is concerned with the history, culture, linguistics, and mythology of the various aboriginal races of America, and generally with the archæology and ethnography of the New World. Correspondence referring to anthropology and ethnography should be addressed to Prof. Karl von den Steinen, Berlin-Charlottenburg, Hardenbergstrasse 24, and that referring to archæology, discovery, and Central America to Prof. Eduard Seler, Steglitz bei Berlin, Kaiser Wilhelmstrasse 3. The general secretary is Prof. K. Lampert, Stuttgart, Archivstrasse 3.

THE volume referred to in the foregoing note affords convincing evidence of the interest shown in scientific subjects in New Zealand, and it is not unnatural to find that men of science in that colony are beginning to ask that scientific principles may influence the national system of education. Mr. Hill, in a paper on technical education, read before the Hawke's Bay Institute, rightly maintained that "the study of natural science should be fostered even beyond the public school course, and this can readily be done by the introduction of botany, geology, agricultural chemistry, and other cognate subjects into the advanced or secondary course. The maintenance by the Government of technical schools and schools of science and agriculture would give prestige to such institutions, and these, with the university colleges, should supply all the academic, scientific, and technical training that is wanted for the professions and the pursuit of every specialised form of industrial work."

THE council of the Royal Society will proceed on November 5 to the election of a Joule student for the period 1903–5. The studentship will be awarded for investigations in those branches of physical science more immediately connected with Joule's work. Applications from candidates will be received by the Assistant Secretary, Royal Society, Burlington House, London, W.

THE first number of vol. ix. of the *Bulletin* issued by the Società Sismologica Italiana gives the rules of that Society, a list of its members, and a continuation,

up to the end of 1901, of the well-known earthquake register compiled at the Central Meteorological Office in Rome. The late appearance of this publication arises from the fact that with the Italian records there are incorporated corresponding records which have been collected from seismological stations throughout the world. In this publication we therefore have not only entries relating to disturbances confined to the Italian peninsula, but also of practically all the large earthquakes of the world.

We have received from the Cambridge Scientific Instrument Company its new catalogue of Duddell oscillographs. These instruments were described in detail in Nature of December 6, 1900 (vol. lxiii. p. 142). Since that time several improvements have been made in their construction which have the effect of making them more trustworthy instruments, and better able to withstand the somewhat rough usage which they are likely to meet with in engineering work. We note also that a double permanent magnet oscillograph is now on the market; this instrument has two sets of strips, and is thus able to show the waveforms of current and P.D. simultaneously; hitherto the portable instrument has only been made with one set of strips. Amongst the illustrations to the catalogue are a number of excellent reproductions of oscillograph records, which serve to show the variety of purposes for which the instrument is suited. One has only to turn to any of the more recent papers dealing with alternate current working to see how important a part the oscillograph is now playing and is destined to play in the future in this branch of electrical engineering.

We have also received from the Cambridge Scientific Instrument Company a pamphlet describing Prof. Callendar's apparatus for measuring the mechanical equivalent of heat, which was recently described before the Physical Society, and a second pamphlet relating to the application of electric resistance thermometry to meteorology. This latter paper sets forth some of the cases in which the use of resistance thermometers is peculiarly suitable, as, for example, the measurement of water temperatures or underground temperatures. The method can be used with much advantage for measuring or recording temperatures at some distance from the observatory, and has the additional recommendation that the thermometer itself need not be disturbed or approached when the reading is taken. We pointed out some of the other uses of these thermometers in these columns a few weeks ago.

In a recent number of the *Bulletin de la Société d'Encouragement pour l'Industrie nationale*, M. Charles Henry has an interesting paper on the luminous efficiency of oil lamps and flames generally. He shows that the efficiency increases with the intensity, at first very rapidly, as the intensity rises from 1 to 2 carcels, and then more slowly, becoming practically constant at 3 carcels. The same has been shown to be true for arc lamps, the law of variation being nearly the same in both cases, only the arc lamp naturally varies over a much wider candle-power range; the efficiency does not become a maximum, in fact, until about 600 carcels. If the efficiencies at their respective maxima are compared, the arc lamp is found to be approximately five times as good as an oil lamp, one carcel-second being obtained for an expenditure of 70 watts in the one case and of 320 in the other; this is allowing for the losses in the boiler, engine and dynamo generating the current, and represents, therefore, the actual superiority of the arc over the oil lamp. If, however, the efficiencies at equal candle-power are compared, the oil lamp is three times as good as an arc—but, of course, an arc of 3 candle-power is never used in practice. The efficiency of the oil lamp may be improved 25 to 40 per cent. by surrounding the lower portion of the flame with a copper ring to prevent loss of heat by convection.

In the *Field* of October 17, Mr. G. Renshaw announces that he has found in the museum of the Royal College of Surgeons a skull of the extinct South African blaauwbok (*Hippotragus leucophaeus*), which is believed to be the only known specimen in existence.

The *Proceedings* of the Royal Irish Academy for May contain an important paper by Dr. G. H. Carpenter on the relationships between the classes of Arthropods. The author considers that group to have been derived from a single stock, and since typical insects, crustaceans, and arachnids possess the same number of segments, the ancestral type must likewise have been definite in this respect. Consequently, millepedes and the like must be aberrant types in which the segmentation has been abnormally increased. Probably the ancestral forms were naupliform (*i.e.* larval) crustaceans, and not, as commonly believed, well-developed annelid worms.

The *Illustrated London News* of last week (October 24) contains a special supplement devoted to the first part of an account, illustrated by reproductions from original photographs, of Major Powell-Cotton's recent hunting expedition in Eastern Equatorial Africa. One of the objects of the expedition was, we believe, to obtain specimens of the okapi, but although the celebrated traveller and big-game hunter has been unsuccessful in this respect, he has succeeded in mapping out an extensive tract of hitherto unexplored country, and has likewise acquired much valuable information with regard to the natives and the fauna. It was during this expedition that the two fine giraffes now mounted in the Natural History Museum were obtained. Special interest attaches to the traveller's discovery of a spot to which elephants resort when about to die, the habit on the part of these animals of having a "dying ground" being paralleled in the case of the South American guanaco. The cave-dwellers of Mount Elgon appear to have made a more favourable impression on Major Powell-Cotton than they did on their discoverer, Sir Harry Johnston. One of the photographs shows a native stalking hartebeests behind an ass on the head of which has been fixed the scalp and horns of one of these antelopes. The conclusion of the account will appear in this week's issue.

At Rossitten, in eastern Prussia, large numbers of crows and rooks are caught alive in nets every year during the two migration seasons. The director of the station of the German Ornithological Society at Rossitten proposes to try a curious experiment with these birds. Small metal rings bearing a number and date will be attached to one foot of each of them, after which they will be liberated and permitted to proceed upon their own paths of migration. Notices have been sent all over Germany requesting that when any of these birds are shot the foot and the ring attached to it may be returned to the director of the "Vogelwarte" at Rossitten. It is quite possible that some of them may stray even as far as the shores of Great Britain, and if this should happen it is hoped that the director's request may be attended to. An accurate record will be kept at Rossitten of the dates of the liberation of every bird and of the locality whence its foot is returned, and it is expected that some interesting deductions will be made from the information thus obtained.

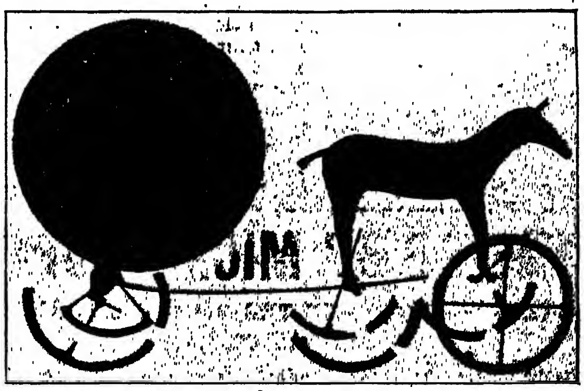
THE small, but well-ordered, zoological garden at Bâle is well worthy of a visit. It is situated in the new quarter of the city beyond the railway station, and has the advantages of a good soil and a clear stream of water running through it. The new lion-house, which will shortly be ready for occupation, is planned on an extended scale, but will not be quite so large as those of London and Berlin. There will be a set of external cages for the animals on the south side, but the interior of the building on the north side will be appropriated to the exhibition of reptiles. There is a fine herd of the American bison, which has frequently bred in this garden, and very good examples of the elk and reindeer, neither of which seem to do well in England. The special pet of the director, Dr. Hagmann, is a young female orang, which has been living at Bâle in good health for more than three years, and is remarkably tame and intelligent. She obeys orders given in German, but has not yet learned to reply to them in that language.

THE geology of the country near Chichester is described in a memoir of the Geological Survey by Mr. Clement Reid, F.R.S., with contributions by Mr. G. W. Lamplugh and Mr. A. J. Jukes-Brown. The memoir, which is accompanied by a colour-printed map (sheet 317), deals with a portion of the South Downs in Sussex, with the picturesque regions of Midhurst, Petworth and Pulborough on the north, and the low-lying fertile tracts of drift gravel and brick-earth on the south. The formations described range from the Wealden to the London Clay, together with Clay-with-flints, certain marine gravels, and other superficial deposits. The price of the memoir is one shilling, and of the map one shilling and sixpence. Both may be obtained from any agent for the sale of Ordnance Survey maps, or through any bookseller from the Ordnance Survey Office, Southampton. For educational purposes this and other memoirs in the same series are invaluable.

THE second part of the general report and statistics for 1902 relating to mines and quarries, edited by Prof. C. Le Neve Foster, F.R.S., and published as a Home Office Bluebook, deals with questions of labour. It gives the facts relating to persons employed and accidents at mines and quarries in the United Kingdom, and to the enforcement of the Mines and Quarries Acts. In 1902, 1061 separate fatal accidents occurred in and about the mines and quarries of the United Kingdom, causing the loss of 1172 lives. Compared with the previous year, there is a decrease of fourteen in the number of fatal accidents and of fifty-seven in the number of lives lost. Three-fourths of the fatal accidents by explosions of fire-damp or coal-dust were due to naked lights, the illegal use of matches, or the illegal opening of a safety-lamp. The worst disaster of the year was the explosion at MacLaren Colliery, Abertysswg, Monmouthshire, where sixteen persons lost their lives and eighteen were injured. In connection with this explosion, Prof. Le Neve Foster remarks, "fortunately the roads were well watered, or otherwise the loss of life would probably have been very much larger"; and in this contention he is supported by Mr. Martin, one of H.M. Inspectors of Mines who reported on the disaster, and concluded his report with the following words:—"This is perhaps the first practical proof of artificial watering limiting the effects of what would otherwise have proved a widespread and much more disastrous affair. It is certainly an object lesson for all colliery managers." Owing to the large number of accidents occurring at quarries from the use of explosives containing nitro-glycerin when in a solid or frozen state, it has been thought desirable to circulate special notices to be posted up on the door of the magazine or store from which the men fetch their explosives. The notice directs that all cartridges made of dynamite, gelignite, blasting gelatin, and other explosives containing nitro-glycerin must always be thawed (in a properly designed warming pan) before use during the months of December, January, February, and March, and also at any other times if the cartridges are not in a soft or pasty condition.

A PECULIAR form of the basidiomycetous fungus *Lentinus lepideus* is described by Mr. W. G. Smith in the *Journal of Botany* (October), in which numerous clavaria-like branches spring from a central club-like portion. Mr. E. G. Baker completes in this number his systematic arrangement of the Indigoferas of tropical Africa.

THE current number (October) of the *Reliquary and Illustrated Archaeologist* contains some notes by Mr. W. R. Prior on an image of the sun found last autumn at Trundholm, in northern Zeeland, and two pictures of the object, one of which is here reproduced on a reduced scale, by permission of the publishers, Messrs. Bemrose and Sons, Ltd. The image is 1 foot 1½ inches broad and 8 inches high, and was found in fragments about six inches under the surface of the ground. It was easily reconstructed by Dr. Sophus Müller, director of the National Museum at Copenhagen, and a full description of the object has appeared in Danish.



Sun Image found at Trundholm, Denmark.

"It has been clearly proved," says Mr. Prior, "an image of the sun being dragged round on a chariot as an object of worship, an idol of the sun-worship dating from about 1000 B.C., and the best of its kind found anywhere, both as regards design and execution. In Egyptian and Oriental mythology, as well as in Grecian, the sun was represented as a round disc, often inlaid with gold. Several pictorial representations of the sun are known from the same period, but none that has any close resemblance to this find. Everything seems to indicate that the find belongs to the older Bronze age, and is of purely Scandinavian origin in its rich ornamental style and artistic workmanship, which appear in northern bronzes of that period."

IN order to obtain flowers out of their natural season, it is possible to retard their growth at an early stage by placing the plants in cold, dry houses, and then to force them later under the influence of heat and moisture, or it is possible to stimulate the young buds into premature development by subjecting them to the effects of ether. M. A. Maumené, a strong advocate of the etherisation system, discusses its scientific and practical aspects in the *Revue scientifique*. He maintains that not only do plants develop more quickly after being etherised, but that development is more regular and complete.

IN Japan the custom prevails of burning down yearly, tri-yearly, or at longer intervals the tracts of ground known as "hara," this name being applied to the bare hillsides which have been denuded of trees. One of the first products on these lands is a grass known as "kaya," *Miscanthus sinensis*, and it is with the idea of increasing this crop that the lands are burnt. This fallacy is combated by Mr. O. Shishido in the *Bulletin* of the College of Agriculture, Tokio, where he points out that the *hara*, although favourably situated, are now practically unproductive areas. In the same journal Mr. H. Shirawasa indicates the development of the oil in the camphor-tree which crystallises out into camphor.

A USEFUL little book has been published by the Royal Geographical Society entitled "Hints on Outfit for Travellers in Tropical Countries," by Dr. Charles F. Harford. The hints are of just the practical kind that intending travellers will find serviceable.

A SIXTH edition of Prof. W. H. Burr's "The Elasticity and Resistance of the Materials of Engineering" has been published by Messrs. John Wiley and Sons, of New York, and Messrs. Chapman and Hall, of London. More than half the book is new, and the advanced matter relating to the general theory of elasticity in amorphous solid bodies, and the theories of torsion and flexure, have been placed at the end of the book as an appendix.

THE Bureau of American Ethnology has published a Natick dictionary compiled by the late Dr. James H. Trumbull. In an introduction Dr. Edward E. Hale explains that the dictionary is published as it was left by Dr. Trumbull, whose widow presented the MS. to the American Antiquarian Society. The manuscript was passed to the late Major Powell, who placed it in the hands of Dr. Gatschet, of the ethnologic staff of the Bureau, who has superintended its publication. It is hoped that the book will form the first volume in a series of vocabularies of the native languages.

IT has been shown recently that the composition of the surface layers of a solution differs to a slight extent from the composition of the solution as a whole. Experiments made by Miss C. C. Benson with very dilute amyl alcohol, which readily gives rise to a durable foam on shaking, show that this foam is also different in composition from the main solution, the proportion of alcohol being slightly greater in the foam than in the rest of the liquid. The composition of the solutions was determined by surface tension measurements by the drop method.

THE problem of turning to practical use the free nitrogen of the atmosphere for the purposes of agriculture and industry is one which has excited attention for many years past. According to a recent communication of Dr. Frank, of Charlottenburg, the fixation of atmospheric nitrogen on a technical scale can be effected through the agency of the carbides of the alkaline earth metals. Barium carbide is especially suitable for the purpose, and by the absorption of atmospheric nitrogen is converted directly into barium cyanide. The reaction with calcium carbide proceeds differently, the product obtained being calcium cyanamide, which, however, by heating with water under high pressure is easily converted into calcium carbonate and ammonia. Experiments have, moreover, shown that the calcium cyanamide can be used directly as a means of supplying nitrogen to the soil.

ALTHOUGH the analogy between asymmetric carbon and nitrogen in regard to optical rotation is assured by the fact that the activity of the nitrogen compounds can be explained by a simple extension of the theory of van 't Hoff and Le Bel, yet previous experiences seem to point to the analogy being very incomplete. The instability and the tendency of the active forms to undergo spontaneous racemisation are conspicuously characteristic of the nitrogen compounds. These properties no doubt depend upon the readiness with which nitrogen passes from the pentavalent into the trivalent form, a transformation which at once destroys the spacial asymmetry. An interesting paper dealing with the subject is published by Dr. Wedekind in the current number of the *Zeitschrift für physikalische Chemie*.

AN investigation of the best conditions for the electrolytic refining of copper has recently been carried out by Messrs. F. J. Schwab and I. Baum, an account of which is given in the October number of the *Journal of Physical Chemistry*. The factors which have been taken into consideration are the cost of the power necessary to precipitate a tank of copper with different current densities and at different temperatures, the cost of heating the tank, the deterioration of the electrolyte, the interest charge on the copper in the tank, and the quality of the copper deposited. As the result of a large number of series of experiments, in which the influence of these factors and their correlation were examined, the authors come to the conclusion that in order to operate a plant most economically and to secure the best financial returns, copper should be refined in covered tanks at a temperature of 70° C., with a current density of 3¼–3½ amperes per square decimetre.

THE additions to the Zoological Society's Gardens during the past week include two Chestnut-breasted Finches (*Donacola castaneothorax*), a Bicheno's Finch (*Estrelda bichenovii*); fourteen Banded Grass Finches (*Poephila cincta*), eight Gouldian Finches (*Poephila gouldiae*) from Queensland, two Modest Grass Finches (*Amadina modesta*), fourteen Chestnut-eared Finches (*Amadina castanotis*); two Undulated Grass Parrakeets (*Melopsittacus undulatus*), a Peaceful Dove (*Geopelia tranquilla*), a Graceful Ground Dove (*Geopelia cuneata*) from Australia, presented by Mrs. Alfred H. Houlder; an American Bittern (*Botaurus lentiginosus*), captured at sea, presented by Mr. Yeo; two Chameleons (*Chamaeleon vulgaris*) from North Africa, presented by Mr. G. T. Coleman; a Hocheur Monkey (*Cercopithecus nictitans*) from West Africa, a Grey Seal (*Halichoerus grypus*) from the West Coast of Ireland, a Red-fronted Lemur (*Lemur rufifrons*) from Madagascar; an Adelaide Parrakeet (*Platycercus adelaidae*) from Australia, deposited; two Great Kangaroos (*Macropus giganteus*) from Australia, a Banded Cotinga (*Cotinga cincta*) from Brazil, purchased; a Hybrid Waterbuck, between (*Cobus unctuosa* ♂ and *Cobus ellipsiprymnus* ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN NOVEMBER:—

Nov. 3. 3h. 45m. to 7h. 2m. Transit of Jupiter's Sat. III. (Ganymede).
7. 11h. 23m. Minimum of Algol (β Persei).
9. 8h. 43m. to 9h. 28m. Moon occults λ Geminorum (Mag. 3·6).
10. 7h. 26m. to 10h. 44m. Transit of Jupiter's Sat. III. (Ganymede).
,, 8h. 12m. Minimum of Algol (β Persei).
14–16. Epoch of Leonid Meteors (Radiant 150° + 22°).
15. 1h. Venus in conjunction with the Moon. Venus 0° 55′ N.
,, Venus. Illuminated portion of disc = 0·429.
16. 6h. 11m. to 9h. 53m. Transit of Jupiter's Sat. IV. (Callisto).
17. 11h. 12m. Transit (ingress) of Jupiter's Sat. III. (Ganymede).
27. 23h. Venus at greatest elongation (46° 44′ W.).
30. 9h. 55m. Minimum of Algol (β Persei).

RECENT SPECTROGRAPHIC OBSERVATIONS OF NOVÆ.—Using the slitless spectrograph recently attached to the Crossley reflector, Prof. Perrine has obtained photographs of the recent spectra of various novæ.

A spectrogram of Nova Aurigæ, taken with a total exposure of 5 hours on August 29 and 30, shows that important changes have taken place in the spectrum of this star since 1901, when the spectrum was photographed by Mr. Stebbins. At that time the chief nebular line at λ 501 was equal in intensity to the lines at λ 462, λ 434, and Hδ, but in the recent photographs it is entirely absent; the other lines are relatively the same, but all appear to have decreased in intensity with regard to the continuous spectrum. This Nova is now of the fourteenth magnitude.

In the case of Nova Persei, a spectrum obtained on July 30, with an exposure of 2 hours 3 minutes, shows that striking changes have taken place since March, 1902. Hβ has decreased greatly in brightness during the interval, and the condensation at λ 434 has also become less marked, whilst Hδ has only suffered the normal diminution in brightness. The lines at λ 339 and λ 346 show the greatest changes, the former having entirely disappeared, whilst the latter is barely distinguishable on the latest spectrogram; the chief nebular line does not appear to have changed relatively to the general spectrum. On July 30 the magnitude of Nova Persei was about 11·5 or 12.

Even in the more recent Nova Geminorum important changes are already noticeable; photographs were secured on August 28, 31, and September 2, and when compared with the observations of May 11 it was seen that during the interval of 3½ months the whole spectrum had become much weaker; the chief nebular line had become much stronger, whilst Hβ had greatly decreased in relative intensity. The line at λ 434 is by far the strongest in the whole spectrum, and that at λ 463 is much broadened and probably composite; there are also indications of the higher hydrogen lines on the background of continuous spectrum. On a number of spectrograms obtained between April 2 and 8 a condensation at λ 350 was a remarkable feature, on April 18 no indications of this condensation were present, whilst on April 26 there was a strong condensation at λ 346, but nothing at all at λ 350; later observations confirm this interesting phenomenon.

Visual observations of the spectrum of Nova Geminorum, made by Mr. H. D. Curtis on August 17 and 18 with spectrograph No. 1 attached to the 36-inch refractor, showed the three chief nebular lines well developed, Hβ faint, the line at λ 4959 rather stronger, and the line at λ 5007, into which the greater part of the Nova's light seemed to be concentrated, very much more intense, whilst D and Hα were not visible. The change of this star into one of the nebular type is apparently now complete (Lick Observatory *Bulletin*, No. 48).

OCCULTATION OF A STAR BY JUPITER.—A communication to the Kiel Centralstelle, published in No. 3903 of the *Astronomische Nachrichten*, announced that Mr. T. Banachiewicz, of the Warsaw University, had observed an occultation of the star B.D.−6°.6191 (mag.=6·5) by Jupiter at about 7h. 10m. (Berlin M.T.) on September 19.

Several observers recorded their observations of this phenomenon in No. 3906 of the *Nachrichten*, amongst others Herr Kostinsky, of the Pulkowa Observatory, who gave the times of immersion and emergence as 20h. 10m. 21s. ±1s. and 21h. 52m. 4s ±1s. (Pulkowa S.T.) respectively.

In a letter to the October number of the *Observatory*, Mr. Denning gives the details of his observations of the phenomenon about half an hour after the probable reappearance of the star, when it was situated at about 10″ from the S.S.E. limb of the planet. He states that the same star will be about 20′ south of Jupiter on December 29 at approximately 10h. G.M.T.

ROTATIONAL VELOCITY OF VENUS.—*Bulletin* No. 3 of the Lowell Observatory contains a description, by Mr. V. M. Slipher, of some experiments made at that observatory in order to determine, by the Deslandres spectrographic method, whether Venus has a short rotational period or not.

The instrument used was the new Lowell spectrograph, made by Brashear, which gives an angular dispersion of 46°.5 for one tenth-metre when set for the minimum deviation of λ 4270. The spectrograph is so attached to the adapter that it may be rotated about the optical axis in order to obtain spectrograms with the slit in various relative positions; the plates used were fine-grain Seed's "23" brand, and were exposed for about 8 minutes during the hour immediately succeeding sunset, whilst the air currents were most quiescent. For purposes of measurement an iron spectrum was photographed on the same plate, and twelve of the finest iron lines were used as fiducial lines. The results obtained show very small probable errors, and indicate that Venus does not possess a short period of rotation. A period of twenty-four hours would cause an inclination of the lines amounting to one-third of a degree, and similar experiments performed on the planet Mars, and published in *Bulletin* No. 4, show that a longer period than this would be clearly indicated by the apparatus and method used.

THE STANDARDISATION OF ELECTRICAL PRESSURES AND FREQUENCIES.

WE have received a copy of the resolutions of the Engineering Standards Committee with reference to standard pressures for direct current and standard frequencies. In view of the importance of the subject to the electrical industry at large, the document is reprinted below in full.

Standard Direct Current Pressures and Standard Frequencies.

The standardisation of electrical pressures and frequencies was the first portion of the important work entrusted to the subcommittee on generators, motors and transformers by the electrical plant committee. The subcommittee consists of the following gentlemen:—

Colonel R. E. Crompton, C.B., chairman.

Colonel H. C. Holden, R.A., Captain A. H. Dumaresq, R.E., representing the War Office.

Commander G. L. Sclater, R.N., Mr. L. J. Steele, representing the Admiralty.

Mr. Llewellyn Preece, representing the Crown Agents for the Colonies.

Dr. R. T. Glazebrook, representing the National Physical Laboratory.

Mr. B. H. Antill, Mr. W. B. Esson, nominated by the Electrical Engineers' Plant Manufacturers' Association.

Mr. A. C. Eborall.

Mr. S. Z. de Ferranti.

Mr. Robert Hammond.

Captain H. R. Sankey.

Mr. C. H. Wordingham.

Mr. Leslie S. Robertson, secretary.

Mr. C. le Maistre, electrical assistant secretary.

At an early stage in their deliberations, the subcommittee decided that the most advantageous method of approaching this problem, beset as it is with so many difficulties, would be from the point of view of those most affected, namely the users of lamps and of motors for power purposes. It was therefore agreed that the standard pressures to be suggested should be measured at the consumers' terminals as settled by Act of 1899.

At the present time there exist many different pressures declared by the various lighting and power authorities. In view of the great desirability of obviating this unsatisfactory state of affairs it was deemed advisable to suggest the minimum number of standard pressures which would best meet present commercial requirements and, at the same time, utilise to the fullest extent the consumers' existing appliances.

After careful consideration, it became evident to the subcommittee that the direct current pressures of 110, 220, 440, and 500 volts would best meet the requirements, because carcases built for these standard pressures could be utilised for pressures 10 per cent. above or below the suggested standards, without any alteration whatever in the castings or mechanical components, by merely altering the windings and excitation.

It is to be hoped that now these direct current pressures have been fixed as standards by the committee, they will in future be universally adopted by the engineers advising

corporations and others distributing electrical energy. In course of time the benefits to the electrical industry at large, which will certainly follow the adoption of these standard pressures, must become more and more apparent.

A circular was drafted embodying the suggestions of the subcommittee, and this was submitted, first to the manufacturers for their consideration, and secondly to the leading consulting engineers and users of motors.

The information so courteously placed at the disposal of the subcommittee by the consulting engineers and manufacturers was most carefully weighed and considered by the subcommittee, and certain definite conclusions were arrived at, the circular being sent, in the first instance, to the manufacturers, as they were the people most directly interested. Replies were received from all the leading firms, who expressed themselves unanimously in favour of the recommendations of the subcommittee. The consulting engineers similarly gave their adherence to the proposals of the subcommittee.

Before coming to their final decision the subcommittee on generators, motors and transformers conferred with the subcommittee on electrical tramways, of which Mr. A. P. Trotter is chairman, and a joint meeting took place, with the result that the pressure of 500 volts, which most concerned the latter subcommittee, was agreed to, and in addition to the pressures already agreed to 600 volts was decided upon as the standard pressure for electrical railways.

The question of the adoption of standard frequencies, although of equal importance with that of standard pressures, was not surrounded with the same difficulties. It was, however, deemed advisable to fix upon the standard frequencies at the earliest possible stage of the work, as no progress could be made in the standardisation of prime movers for driving alternate current machinery until such time as the frequencies had been settled upon. On this question there appeared to be a great preponderance in favour of frequencies of 25 and 50. The only point upon which any serious difference of opinion appeared to exist was the advisability of the adoption of a third frequency of 40 or 42, to enable rotary converters to be used to the fullest advantage. All the arguments in favour of this third frequency were fully discussed, but after carefully weighing the *pros* and *cons* the subcommittee decided not to recommend the adoption of more than two frequencies, namely, 25 and 50.

The recommendations of the subcommittee were then submitted to the electrical plant committee, the publication committee, the main committee, and the Board of Trade for their approval.

This having been obtained, it was deemed advisable, in the interests of the electrical industry of the country, that the findings on the questions of direct current pressures and frequencies should be published at an early date, without waiting for the completion of the entire report to be issued at a later date.

The following are the resolutions on standard direct current pressures and standard frequencies:—

(1) That the standard direct current pressures, measured at the consumers' terminals, be:—

110, 220, 440, 500 volts.

(2) That the standard direct current pressures, measured at the terminals of the motors, be:—

For tramways 500 volts.
For railways 600 volts.

(3) That 25 periods per second be the standard frequency for:—

(*a*) Systems involving conversion to direct current by means of rotary converters.
(*b*) Large power schemes over long distances.
(*c*) Three phase railway work, where motor gearing and the inductive drop on the track rail have to be considered.

(4) That 50 periods per second be the standard frequency for:—

(*a*) Mixed power and lighting on town supply mains.
(*b*) Ordinary factory power plant.
(*c*) All medium size power plant where rotary converters are not employed.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

The present transitional phase of geographical thought and activity was faithfully mirrored in the proceedings of Section E. The majority of the papers revealed the wide range of geographical interests rather than any great advance in geographical coordination. In this they are typical; for while there are many workers at geographical problems, few, if any, would put forth the claim of being complete geographers. There are indications of many geographical specialisms being recognised. Their exponents are, however, at one disadvantage when compared with other specialists. An organic chemist usually has had a thorough training in chemistry before he specialises in organic chemistry. Few geographical specialists have had any training as geographers. Each makes his own contribution, but it is often an isolated one, and does not fit into a general plan of the subject. The unity of geography and the relation of its parts are very gradually being elucidated. The want of this coordination is strongly felt by most geographical workers. At the conclusion of the Southport meeting one wished for a summary coordinating the communications discussed. Perhaps this is felt, though to a less extent, in other sections, and it would be useful if the presidential duties were made to conclude by the giving of a brief review of the work done at the section.

The address of the genial president, Captain Creak, was the only one which surveyed the whole world. It was on terrestrial magnetism, and has already been printed. Dr. Vaughan Cornish's researches, summarised in the report of the committee on terrestrial surface waves, are on worldwide phenomena, which he illustrated on this occasion mainly by beautiful views of the wave forms of Niagara, from which he has recently returned, and by pictures of wave forms in snow and on quarry roads caused by heavy sledge traffic.

The section was also privileged to hear an address from Prof. Pettersson, of Stockholm, who spoke for an hour in excellent English, on the effect of ice melting on oceanic circulation. Prof. Pettersson has long insisted that the thermodynamic cycle of latent heat, consisting of ice formation in polar regions and of ice melting in sea-water in lower latitudes, was a potent cause of oceanic currents. He has calculated that the ice melting between Iceland and Jan Mayen generates about 400,000 horse-power annually, which is expended in accelerating the water movements of the east Iceland polar current. The energy set free on ice melting in sea-water maintains a kind of inverted waterfall, an upwelling of bottom water to the surface. Warm currents follow the trend of deepest isobaths, ice currents exist only in shallow seas, where no warm current can melt them. Ice currents and warm currents meet between Iceland and Jan Mayen, west of Spitsbergen, south-east of Newfoundland, and round the margin of the ice-girdled Antarctic. The "outbursts" of Antarctic icebergs which carry them to low latitudes in the Indian Ocean may influence the climate of India and Australia. The latest Antarctic outburst and series of great droughts in India occurred between 1891–98. Prof. Pettersson considered that regular surface observations between 60° and 100° E. and a few series of deep-sea soundings would reveal hydrographical variations with important meteorological bearings. He also pointed out that current measurements at depths of 800–4000 metres in the Atlantic were needed to ascertain the significance of the currents generated by ice attraction. At the conclusion of his paper Prof. Pettersson showed in miniature an experiment to illustrate the effect of melting ice in causing currents in salt water carried out by Mr. J. W. Sandström, assisted by Miss A. Palmquist, who have made a series of useful calculations from the data obtained from this experiment.

Travellers' tales were few, but full of human interest. No one who heard Lieutenant Shackleton will forget the vivid and racy account he gave of the National Antarctic Expedition. Dr. Tempest Anderson's slides and descriptions of the volcanic phenomena of St. Vincent and Martinique were equally effective. Lieut.-Colonel Manifold described his journeying from India across China, and back over different routes through the heart of the Empire. In his paper were many hints of the great activity of other Powers

than Britain in pushing on railway construction and promoting the expansion of their commerce. Dr. H. O. Forbes read a report on the work of his expedition to Sokotra. Dr. J. P. Thompson, the energetic Queensland geographer, contributed a comprehensive account of the geography of the State.

Exploration is now no longer confined to foreign lands, and some of the younger botanists have shown us what can be done when the plant world at home is regarded geographically. From the point of view of pure science they are making an important contribution to the study of the relationship between organisms and environment, and compiling part of the data necessary for the study of macro-organisms—the complex associations of rock, air, water, and organic life considered as a whole, which are the subject-matter of the geographer. From the point of view of applied science they are carrying out an equally valuable work, for a knowledge of the characteristics and distribution of the different plant associations is the best clue to the possibilities and limits of their profitable exploitation for the production of economically important plants and animals. Such botanical surveys might well be subsidised by the Board of Agriculture. The example of the Canadian Geological Survey might be followed, and the work be entrusted to teachers of botany who would carry it out in their vacations.

Dr. Otto Darbishire, of Owens College, discussed the general problem of the relations of botany and geography, and insisted on the necessity for modern travellers having a knowledge of ecology. Dr. W. G. Smith, of the Yorkshire College, who has carried on the work of his deceased brother, who planned a botanical survey of Great Britain, also urged the importance of the observation and mapping of vegetation features in geographical exploration, and illustrated his thesis by reference to the maps already made for Britain. The maps made of the plant associations of the Eden, Tees, Tyne, and Wear basins by Mr. F. J. Lewis, of University College, Liverpool, were shown and described; and Mr. Moss discussed the age and origin of the peat moors of the southern Pennines.

One of the applications of botanical geography to practical affairs was well illustrated in a valuable paper by the chief engineer of the Liverpool Waterworks, Mr. Parry, who has been the pioneer in the afforestation of the catchment areas of water reservoirs, which has been proved to increase the purity of the water supplied to the citizens and to protect their pockets. Mr. E. D. Morel also discussed a problem in applied geography. He pointed out the value of West Africa for the production of raw cotton, and the results that had been obtained by appealing to the commercial instincts of the natives instead of having recourse to coercion. The importance of a study of native land and administrative systems was emphasised.

Mr. E. A. Reeves read a timely paper on the nature of geographical surveying suited to present requirements, when route charts must be replaced by maps based on surveys planned on scientific lines, while not so elaborate or accurate as large trigonometrical surveys. Mr. E. Heawood contributed the one paper on the history of geography. He discussed the newly discovered maps of Henricus Glareanus, who first described a convenient method for constructing the gores of a globe. One of his maps is the earliest known which shows a hemisphere on an equidistant polar projection.

The geography and education sections held a joint sitting to discuss geographical education. Mr. H. J. Mackinder opened with an eloquent exposition of the regional method of teaching geography and of the possibility of weaving into the regional treatment so much as is needed of other sciences by taking these one at a time in the successive stages of the strictly geographical argument. He submitted that geography could be placed in its rightful position only by the simultaneous application of a four-fold policy:—(1) The encouragement of university schools of geography where geographers should be made, of whom many would become secondary teachers; (2) the appointment of trained geographers as teachers in our secondary schools, either for geography alone or for geography and general help in other subjects; (3) the general acceptance of a progression of method in the subject, not expressed in detailed syllabuses issued by the State or other dominant authority which would tend to stereotype teaching, but in a tradition similar to that which at different times has governed the teaching of language and mathematics; (4) the setting of examinations by expert geographical teachers.

Mr. Hugh Richardson gave a valuable account of how he taught his pupils from thirteen to seventeen years of age the use of maps and books, and insisted on the value of laboratory work on which their books gave little help. Mr. Hewlett spoke of aims and difficulties in the teaching of geography, and Mr. Cloudesley Brereton of geography in secondary education.

In the discussion which followed, the main objections urged against Mr. Mackinder's ideas were that sufficient time was not allowed for carrying them out, and that it was impossible to adopt his suggestion that pupils should be grouped in special sets for the geography lessons. The need for teachers who have had a training in geography, and the value of geography as a coordinating subject in the curriculum, seemed to be recognised by all.

A. J. H.

ENGINEERING AT THE BRITISH ASSOCIATION.

THE section had a lengthy programme to work through at Southport, but it must be confessed that there were but few papers of outstanding importance.

On Thursday, September 10, after Mr. Hawksley's presidential address, which naturally dealt mainly with the problem of the supply of water to cities and villages, a paper was read by Mr. C. A. Brereton on the new King Edward VII. bridge over the River Thames, at Kew. The author showed some interesting lantern slides to explain more clearly the method of construction adopted in previous bridges which crossed the river at this site, and also in the case of the new structure. It was not until 1892 that, induced by the increase in the traffic and the inconvenience caused by the narrowness of the old bridge and the steepness of its gradients, the County Councils of Surrey and Middlesex decided to take steps to replace the bridge by a new one; the necessary Act of Parliament was eventually obtained in 1898, the contract was then let to Mr. Gibb, and the work was begun at once.

The bridge consists of three elliptical arches, the centre one being of rather longer span than the two side arches; it has a span of 133 feet, and a headway of 20 feet above Trinity high-water mark, while the two side spans are only 116 feet 6 inches in span, with a headway of 17 feet. The piers from which these three arches spring are carried down into the solid London Clay at a depth of 18 feet below the bed of the river. The width of the carriage way is 36 feet, and there are 9 feet 6 inch footways on either side; the maximum gradient is only 1 in 40. The whole of the arches, and the exterior of the piers, is constructed of solid granite, chiefly Cornwall and Aberdeen, many of the big stones weighing as much as 8 tons each. To provide for the traffic during the construction of the new bridge, a temporary timber bridge was put up alongside the old one; this was completed in the remarkably short time of six months. The cofferdams for the piers of the new bridge were started in December, 1899, and but little difficulty was met with in their construction. All three arches were constructed simultaneously, and therefore it was necessary for all the stones for the arches to be brought on to the ground before the turning of the arches was commenced; every stone was numbered and placed in the receiving yard ready to take its place in the work. The masonry of the arches was commenced in May, 1902, and completed in December of that year—an extremely expeditious piece of work. The total length of the bridge proper is 502 feet, the approaches on the Middlesex and Surrey sides bringing the overall length to 1182 feet. The bridge was opened by His Majesty the King on May 20 last, having taken about three and a half years to construct; one year was occupied in the construction of the temporary bridge and the removal of the old bridge.

The only other paper dealt with on the Thursday was an interesting contribution by Mr. J. Harrison—illustrations of graphical analysis. The author gave an account of a simple graphical method of obtaining equations for the displacement of the valve, and for the sliding of the block in the link in an ordinary Stephenson's link gear. In fact, it

was a graphical method of analysing a Fourier series, the author's methods being exceedingly neat and handy, but requiring very exact and careful draughtsmanship.

The first paper taken on Friday, September 11, was specially written in order to prepare members for the visit of the section on Saturday to the new Manchester Municipal Technical Institute. Principal J. H. Reynolds gave, with the aid of a number of lantern slides, an interesting account of the construction and equipment of this great technical institute. The author's paper was practically a defence of the methods which have been adopted in connection with the equipment of the engineering and other departments of this Institute; the authorities have been attacked for fitting up their laboratories with unnecessarily complicated apparatus, probably beyond the capacity of the class of students they are likely to have, and it must be admitted that there is some justification for this criticism. Members of the section were better able to form their own opinion on this controversy after the visit on Saturday. As regards the strength of materials laboratory, the machines are those ordinarily employed, with the addition of a very powerful appliance for compression purposes, but as it happens to be extremely simple in construction, being nothing more or less than a modified cotton press, it can be used as easily by students (though its capacity runs into hundreds of tons) as if it were a machine of only a few tons capacity. In the steam engine laboratory, however, there is no doubt that the experimental engine, a fine piece of design due to Prof. Nicolson, is on too big a scale for teaching purposes; it may be an admirable instrument for research in the hands of Prof. Nicolson, and therefore the authorities of the college may be justified in the expenditure which must have been incurred both in the original purchase of this engine and in its working expenses, but for the instruction of the students likely to frequent such a technical institute, it would have been far better to have provided half a dozen engines, each, say, of 10 to 15 horse-power, and each of a different type. The changes in essential points in the design of prime movers of all kinds, and in fact of most machinery, come so rapidly, that if a college is to keep its equipment up to date, it should not be of too expensive a character, as it will be necessary pretty frequently to scrap apparatus, and replace it by newer plant more in accordance with the practice and design of the day. Another criticism which might be offered upon the equipment of the whole college is that too much apparatus has been put in at once; it would have been undoubtedly wiser to have arranged for the equipment to be gradually and steadily increased year by year as the number of students increased, and the demand for such increased apparatus arose.

At the conclusion of this paper, and after a brief discussion, the report of the committee on the resistance of road vehicles to traction was taken, and the committee was reappointed for another year. The work of this committee is of such great importance that it will be desirable to direct attention to this report and the work carried out by the committee a little later on in a special article.

Mr. T. Clarkson's paper on improvements in locomobile design was then read. The author is a strong supporter of steam-driven cars; he claimed that there was greater trustworthiness in the case of steam, more certainty in action, more reserve power, that it would to a great extent render unnecessary expensive change speed gears, and that by the use of liquid fuel, burnt in scientifically designed furnaces, there was no smoke and no trouble from the smell produced during the process of combustion. The paper was full of descriptions of exceedingly clever details, such as an ingenious method of automatically controlling the feed when going down or up hill, the pumping of oil under pressure to lubricate every bearing and every moving part, the use of metallic packing, necessary on account of superheated steam being used in the cylinders, and other ingenious devices. If the steam car is ever to be a formidable rival of the oil-driven car, it will certainly be due to the labours of such indefatigable scientific workers as Mr. Clarkson.

The remainder of the day was devoted to a discussion, opened by Lieut.-Colonel Crompton, on the problem of modern street traffic. Unfortunately the discussion came on so late that many had gone away for the day who might otherwise have taken part in it, and no very practical suggestions were made by any of the speakers except that further attention should be paid to the regulation of slow, heavy traffic. It is, however, after all a moot question whether there is so much street obstruction or so much difficulty with the control of modern street traffic as the daily Press would make us believe. Apart from a few of the main thoroughfares in London itself, there is very little delay in our cities caused by congestion of traffic, except in exceptional circumstances and on exceptional days. Colonel Crompton alleged that electric trams were as slow as the old horse omnibuses; if so, his experience of such trams must be very unfortunate; certainly this is not the experience of most people, and in towns like Glasgow, Manchester, and Liverpool, the introduction of electric traction has certainly much increased the speed at which one can pass from one part of the town to another, and in these cities the problem of street traffic is not complicated as it is in a few of the leading thoroughfares in London by the crawling cab nuisance. Probably without inconvenience to the general public many of the cabs in London might be withdrawn, and certainly by a judicious arrangement of underground tube railways, and by the extension of the electric tramway service, the greater part of the cumbersome, slow-moving, obstructive omnibuses might be driven from the streets, and it is in this direction, rather than in expensive widenings and overhead bridges, that the problem of congestion in the central streets of London will have to be met.

Monday, September 14, was devoted almost entirely to electrical papers. The first of these was one by Mr. W. B. Woodhouse on protective devices for high tension electrical systems. The author, who has had considerable experience in work of this nature, briefly described the necessary protective appliances, such as circuit breakers and the devices for preventing or relieving excessive rises of pressure, which are required in high tension electrical power systems. He described several fuses and switches and overload relays which had been found effective in actual practical operation; as regards switches, he was of opinion that the oil-break switch did break circuit at the moment of zero current, and that for this reason it was the one which should be generally adopted. This paper led to an interesting discussion, in which Mr. G. Kapp and Prof. Ayrton were the chief speakers.

Then followed two papers on aluminium as an electrical conductor, one by Mr. J. B. C. Kershaw and the other by Prof. Wilson. Both authors have been experimenting on the effects produced by exposure of aluminium wires and rods to atmospheric influence. Mr. Kershaw's experiments have been conducted on the Lancashire coast, just south of Southport, and Prof. Wilson's in London, on the roof of King's College. Both experimenters found that the aluminium had suffered considerably; Mr. Kershaw found serious corrosion due to the sea air, especially on the under side of the wires, where drops of water had hung for a long time. Prof. Wilson's experiments were a continuation of an earlier series of tests which were described at a previous meeting, and dealt with the effect of atmospheric corrosion on the conductivity of the metal; the later experiments confirm the results obtained in the earlier ones, namely, that an alloy of aluminium with copper alone was inadvisable for electrical purposes when exposed to the atmosphere, as its conductivity diminished steadily, though more slowly after a time.

Of the other papers taken, the most important was that by Mr. B. Hopkinson on the parallel working of alternators; the paper—a highly technical one—it is impossible to summarise. The author dealt with the practical problem of keeping the oscillations, with their accompanying fluctuations in the flow of energy to or from the main or 'bus bars, within moderate limits, and he treated the matter both from the mathematical point of view and in its practical applications.

On Tuesday, September 15, a lengthy programme was dealt with, and we can only refer to a few of the papers. Mr. W. F. Goodrich, in a paper on twenty-five years' progress in final and sanitary refuse disposal, gave some valuable figures as to the progress which has been made in this branch of sanitary engineering. No less than 180 towns are now using destructors; in 63 of these the steam generated is used in electricity works, and in 40 in connection with the pumping plants of the town sewage works, while in 3 cases the power available is utilised by water-

works pumping engines. As a result of numerous tests it might be roughly estimated that every ton of refuse burnt generated about one ton of high pressure steam, and that with the modern high temperature destructor cells the smell and dust nuisances were practically banished.

Liquid fuel was the subject of Mr. A. M. Bell's communication; much information was given as to the various sources of supply and also as to the best types of oil-burning apparatus, and the author quoted some striking figures obtained in recent tests. In a test at Messrs. John Brown and Co.'s works, 16.09 lb. of water were evaporated per pound of Texan oil burnt, the boiler having an efficiency of 84 per cent.; of course a certain proportion, the author says never more than 3 per cent., of the steam is needed for spraying the oil; with a Stirling boiler, which had an evaporation at standard conditions of 10·55 lb. of water per pound of Welsh coal burnt, the evaporation had been increased to 15·42 lb. per pound of Texan oil, when the furnace was suitably modified for oil consumption. It was pointed out in the discussion that still more economical results could be obtained when this oil was used in internal combustion engines.

Dr. H. R. Mill gave the section some interesting data as to the rate of fall of rain at Seathwaite, and pointed out that in these west coast regions of heavy annual fall the maximum rate of fall was nothing like so great as may occur during heavy summer thunderstorms in drier parts of the country, where it may equal at times 3 inches in the hour.

The last paper of the day was one by Mr. R. Pearson on natural gas in Sussex, and it will astonish most persons to learn what a large amount of gas is now obtained in this district. At Heathfield some eighty houses are using it for lighting and heating purposes, and gas engines utilising it develop a horse-power on a consumption of about fifteen cubic feet of the natural gas per hour. With the development of the Kentish coal-fields and the Sussex gas and oil-fields, both by no means improbable in the early future, there is no doubt that the south-eastern corner of England would undergo an industrial revolution; much as one might regret to see its lovely rural and pastoral character disappear, everyone would welcome the advent of manufacturing industry into this somewhat sleepy corner of the kingdom.

The section had, in consequence of its lengthy programme, to sit on the morning of Wednesday, September 16, when a number of very interesting communications were dealt with. Members of the staff of Messrs. Willans and Robinson contributed two papers—Mr. C. H. Wingfield described experiments on the permanent set in cast-iron as bearing on the design of piston-ring springs, and Mr. Izod a piece of apparatus for testing the brittleness of steel. Both papers are the outcome of the constant experimental research going on in the modern up-to-date engineering workshop, and are a sufficient answer to the reproaches of those who, knowing little or nothing of what they write about, are constantly declaring that trade is leaving the country owing to the apathy and stupid conservatism of our manufacturers. Both communications should be carefully studied by those engaged in the study of the strength of materials.

Mr. W. Odell described some experiments he had carried out to determine the power wasted by the windage of fly-wheel and dynamo armatures, and he stated that a 9-foot disc running at 500 revolutions a minute would absorb about 10 H.P. Mr. W. Cramp read a paper on single phase repulsion motors, a matter of great practical importance in electric tramway work; he claimed that the problem had been solved, and that a single phase alternating current motor had been designed quite equal to a direct current motor.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE anthropological section met in the Town Hall, Southport, under the presidency of Prof. Johnson Symington, F.R.S., of Queen's College, Belfast, and, as usual, attracted large audiences. The programme was a full one, and the principal communications were in the department of Egyptian, Mediterranean, and British archæology, a fact which is partly attributable to the widespread feeling—very clearly expressed by the President of the Association in the course of one of the discussions—that the human sciences, in the older and more academic sense, fall properly within the scope of the Association's work, and merit scientific recognition.

Most important, perhaps, among these new accessions to the section's programme was the group of papers on work in Roman Britain, an area where a subject, which elsewhere can be treated in the full light of written history, has to be explored almost wholly by the methods of prehistoric archæology; and the appointment, with a small grant, of a committee of the Association "to cooperate with local effort on Roman sites in Britain" cannot fail to strengthen both the subject and the section at large.

The president's address, which dealt with the relations between brain and skull, and with the problems which result, has been already printed in full (October 1, p. 539), and gave a broad and philosophic tone to the opening discussion; but the subsequent papers on points of anthropography dealt almost wholly with detailed work of a somewhat specialist kind. Dr. Wm. Wright's account of the skulls from round barrows in east Yorkshire, now in the Mortimer Museum at Driffield, led to the conclusion that the old dictum enunciated by Thurnam—"round barrow, round skull"—is not even approximately accurate for this area, for the cephalic index ranges from 69 to 92, and almost all the European varieties of cranial shape are represented. A marked resemblance, however, was frequently noted between the skulls from any one barrow.

Mr. W. L. H. Duckworth's investigation of the physical anthropology of Crete and Greece, though still incomplete, has brought together a large mass of new material of many periods for the reconsideration of the ethnology of the Ægean area. The bones from the pre-Mycenæan ossuaries of Palæokastro, in eastern Crete, show a purely Mediterranean type, which is shared by those from Mycenæan interments on the Greek mainland; whereas even in Crete, and universally on the mainland, the modern population betrays by its brachycephaly a large admixture of Albanian, Venetic, or Slav intruders. Eastern Crete, however, is more brachycephalic now than the central districts, and this Mr. Duckworth is inclined to attribute to intrusions from Asia Minor. A further grant made by the Association will, it is hoped, enable Mr. Duckworth to continue this very promising inquiry.

Dr. E. J. Evatt's observations on the pads and papillary ridges on the palm of the hand showed that the fœtal disposition of these pads resembles that in the mouse and some other lower animals, which is probably morphologically equivalent. In the adult the pads are to be regarded as vestigial. The papillary ridges are produced by the invasion of the corium by the underlying layer; the interlocking of the two probably serves to connect them more strongly; and the patterns are due to the stresses of prehension acting on ridges which originally lay transversely.

Mr. N. Annandale, in describing a collection of skulls from the Malay Peninsula, noted the great development of the cerebellar part of the occiput, and a widespread abnormality of growth of the third molar.

The committees on a pigmentation survey of the school children of Scotland, and on anthropometric investigations among the native troops of the Egyptian Army, presented interim reports of a formal character. In the latter case the 17,000 measurements already taken cannot apparently be worked up for publication without expert clerical assistance, and it is much to be hoped either that this may be provided without undue delay, or that the committee may see its way to hand over its data to one or other of the biometrical centres which have such assistance at their disposal.

The committee appointed to organise anthropometric research presented a short but very useful report. A single year's work has sufficed to collect and collate the experience of practically all the centres at which anthropometric work is being carried on, as to objects of research, methods, instruments, schedules, and the like, and it is next proposed to inquire under what conditions of maintenance and administration a collection of anthropometric statistics could be established as the nucleus of more systematic investigations. The preface to the report, by Prof. Cleland,

the chairman of the committee, is a valuable summary of the objects and methods of anthropometric work.

The president's brief account of Grattan's craniometric methods illustrates well the need for some such coordination of inquiry as the above-named committee proposes to supply. Grattan's work in radial craniometry, and his very ingenious craniometer, which is now in Prof. Symington's keeping, remained unpublished and unknown until long after similar methods had been rediscovered independently by other workers.

In general ethnography the papers were also few and of various quality. Dr. W. H. R. Rivers's researches on the psychology and sociology of the Todas formed the subject of a committee report, which was supplemented by two papers on special points by the investigator. By the same genealogical method as he employed in Torres Straits, Dr. Rivers has succeeded in unravelling the complicated scheme of kinship and marriage restrictions. This system is of the kind known as "classificatory," every male of an individual's clan being either his grandfather, father, brother, son, or grandson, and so forth. Marriage is regulated by kinship, being prohibited between the children of brothers and between the children of sisters, but being customary between children of brother and sister, and when a girl becomes the wife of a boy she is understood to become also the wife of his brothers. Infanticide certainly was practised formerly, but it is strenuously denied now.

In a separate paper Dr. Rivers described the elaborate ritual of the Toda dairy, in which the dairyman is the priest, and the whole industry endued with a religious character.

The account of the ancient monuments of northern Honduras, &c., presented by Dr. T. W. Gann, described a large number of temples, pyramids, fortifications, underground buildings, monoliths, and ancient enclosures for various purposes, and also the pottery, implements, and ornaments attributable to their builders; with notes on the burial customs and general civilisation of the ancient inhabitants, and observations on the modern ethnography and of the influence of European civilisation on the aborigines.

Dr. J. E. Duerden communicated a note on a type of wooden image which is widely distributed in cave deposits in the West Indian islands.

Miss Pullen Burry's account of the rapid evolution of the Jamaica black gave a favourable picture of the social condition of the negro population. Obeah-worship is practically extinct, peasant-proprietorship has inspired a taste for agriculture, and life and property are safe even in the remoter districts.

Mr. C. Hill Tout and Mr. David Boyle sent papers on the ethnology of the Siciutl Indians of British Columbia and on the Canadian Indians of to-day, but the committee on an ethnographical survey of Canada, of which they are members, presented no report this year.

An account of the legends of the Dieri and kindred tribes of Australia, by Messrs. A. W. Howitt and Otto Siebert, contained much new and valuable matter, but did not lend itself to presentation in full. It will be published shortly in the *Journal* of the Anthropological Institute.

Other papers, of a more or less ethnographical character, raised questions of general importance, and provoked useful discussion.

Mr. W. Crooke's examination of the progress of Islam in India and its causes laid stress on the successful Mohammedan propaganda, which, together with the higher social status of the caste-free Mohammedan, has resulted in considerable conversion of Hindus to Islam, and also on the circumstance that hereditary vigour, maturer marriage, and more varied and invigorating diet tend to make the Mohammedan individual more fertile and more long-lived than the Hindu.

Prof. R. S. Conway, in discussing the ethnology of early Italy and its linguistic relations with that of Britain, dealt almost wholly with the linguistic evidence of early Italian place- and tribe-names, recurring thus, after a considerable interval, to a department of anthropological inquiry which has been overmuch neglected in this section. He distinguished two main sets of ethnics, one ending in -CO the other in -NO. The occurrence of ethnics in -CINO (*i.e.* -NO superimposed upon -CO) shows that the -NO stratum is the later, and its geographical distribution leads Prof. Conway to connect it with the irruption of the northern group of peoples into Peninsular Italy, who had knowledge of iron and buried their dead. To these, contrary to the view of Mommsen and his school, Prof. Conway holds that the *Romani*, or at all events their aristocracy, belonged, and he explains the peculiar geographical distribution of the Italic dialects of Umbria and the Volscian area by the probable effects of this northern invasion, coinciding, as he supposes, in point of time with the Tyrrhenian colonisation of Etruria. He compares the linguistic contrasts which separate the -CO and -NO folk in Italy with those which distinguish Goidels and Brythons in north-western Europe, and suggests that the westward and the southward movements which can be traced are to be referred to the same centre of disturbance.

Mr. D. MacRitchie argued, from the survival of the use of skin-covered canoes in N.W. Europe, to the existence of a racial type of Mongoloid Europeans. It should be noted, however, that one might sit in a skin-covered canoe without having Mongoloid physique.

In contrast with the somewhat meagre output in ethnography, the archæological communications were unusually numerous and attractive.

Mr. Llewellyn Treacher's paper on the occurrence of stone implements in the Thames Valley between Reading and Maidenhead (read also in Section C), and Mrs. Stopes's account of her late husband's collections from implementiferous gravels at Swanscombe, in Kent, summarised much useful work on limited areas. Mrs. Stopes's other paper, on saw-edged palæoliths, submitted a wide induction from copious data; so copious and varied, indeed, that the preliminary question intruded itself whether nature, as well as man, had not some hand in their preparation.

Mr. Annandale was on safer ground in his collection of survivals of primitive implements in the Faroes and Iceland, and exhibited a great variety of types. Their distribution is by no means uniform, those found in the Faroes being generally absent from Iceland, and *vice versâ*. Mr. Annandale suggests that this may be due to differences in the history of the original settlers in the two areas.

A paper by Mr. G. Clinch described the megalithic monument of Coldrum, in Kent, which comprise a central cromlech, without capstone, but with a double chamber, and an irregular line of large blocks of stone on the western side, with traces of a tumulus. No excavation has been attempted as yet, and the monument is partly destroyed by a cart-way, but the author compares it with a larger megalithic structure, of Neolithic date, at Sievern, in Hanover, and concludes in favour of a late Neolithic date for Coldrum. He lays stress on points of similarity which he detects between Coldrum and Stonehenge. Discussion and criticism were impaired in this, as in some other cases, by the absence of the author.

Mr. H. Balfour gave an account of a model of the Arbor Low stone circle, which had been prepared by Mr. H. St. G. Gray as the outcome of the recent excavation of this monument by a committee of the Association. It would be well if every such excavation were so conducted as to permit a similar reproduction for convenient reference hereafter.

Prof. W. Ridgeway offered a suggestive theory of the origin of jewellery, namely, that mankind was led to wear such objects by magic rather than by æsthetic considerations.

All peoples value for magical purposes small stones of peculiar form or colour long before they can wear them as ornaments; *e.g.* Australians and tribes of New Guinea use crystals for rain-making, although they cannot bore them. So, in Greece, the crystal was used to light sacrificial fire, and was so employed in the Church down to the fifteenth century. The Egyptians under the twelfth dynasty used it largely, piercing it along its axis. From this bead came the artificial cylindrical beads made later by the Egyptian, from which modern cylindrical glass beads are descended. The beryl, a natural hexagonal prism, lent itself still more readily to the same form, and the cylinders found without any engraving on the wrists of the dead in early Babylonian graves had a similar origin. The Orphic Lithica gives a clear account of the special virtue of each stone, and it is plain that they acted chiefly by sympathetic magic. The Greeks and Asiatics used stones primarily as amulets, and to enhance the natural power of the stone a device was cut on it. The use of the stone for sealing was simply secondary, and may have arisen first for sacred purposes.

Shells are worn as amulets by modern savages, *e.g.* cowries in Africa; red coral is a potent amulet worn by travellers by sea; pearls are a potent medicine in modern China; seeds of plants are medicine everywhere; and the claws of lions are worn as amulets all through Africa, and are "great medicine," and imitations of them are made.

When gold becomes first known it is regarded exactly like the stones mentioned. Thus the Debæ, an Arab tribe, who did not work gold, but had abundance in their land, used only the nuggets, stringing them for necklaces alternately with perforated stones.

Magnetic iron and hæmatite were especially prized, the power of attraction in magnetic iron, as in the case of amber, causing a belief that there was a living spirit within. Hence iron in general was regarded with peculiar veneration, and not because it was a newer metal, as is commonly stated.

In a paper on the origin of the brooch, and the probable use of certain rings at present called "armlets," Mr. E. Lovett suggested, as the prototype of the ring-and-pin contrivance for fastening a cloak, the use, by a hunting people, of the mammalian *Os innominatum* and *Os calcis*. He noted, further, that very many rings of early date, usually described as "armlets," are too small to allow the entrance of a hand. As such rings are frequently found associated with pins of similar materials, commonly regarded as "hair-pins," and as ring and pin are sometimes found *in situ* on the breast of a skeleton, he infers that they represent a simple ring-and-pin fastening of the kind described above. An apron-fastener of this type, composed of an iron ring and a horse-shoe nail, is still worn in some of the blacksmith's shops in Scotland. The next step of development follows when the pin is perforated at the thick end and attached to the ring by a fibre to prevent it from being lost. This stage is actually represented in China. A further step is taken when the pin itself is hinged upon the ring, for security, by bending its flattened head round the ring, a form which is abundant in Celtic times. The inconvenience which accompanies the ring-and-pin brooch, that the fabric must be drawn so far through the ring, was remedied by leaving a gap in the ring; the "penannular" brooch results.

Miss Bulley exhibited a number of examples of crosses, chiefly Celtic, and traversed familiar ground in inferring from them the existence of a distinct type of symbol in which a circumscribed circle is of equal importance with the cross itself. Coptic and Syrian crosses show the same type as the Celtic, though not so markedly. The subject, if treated at all, needs much more thorough examination.

Mr. John Garstang's account of Egyptian burial customs summarised the results of his discovery of a necropolis of the Middle Empire (about 2200 B.C.) at Beni-Hasan, in Upper Egypt, which contained burying places of minor officials and distinguished women, and illustrated the funeral ritual of the middle classes of the locality. These tombs are not large enough for mural decoration, but they are furnished with numerous wooden models—boats, granaries, and men and women engaged in field-work and household duties—which explain many points connected with the burial of the dead. The objects seem to have borne no relation to the profession of the deceased, but are simply of religious motive—the elaborate provision for a future journey.

Dr. C. S. Myers described the antiquities of Kharga in the Great Oasis, which include a well-preserved temple of Hibis, which is one of the most important monuments of the Persian dynasty in Egypt, and an early Nestorian necropolis, with streets of tombs and funeral chapels of unburnt brick, plastered and frescoed with symbolic ornament and Biblical scenes.

Prof. Flinders Petrie summarised the principal results of his recent excavations at Abydos in two demonstrations entitled "The Beginning of the Egyptian Kingdom" and "The Temples of Abydos." The discovery of the prehistoric age of Egypt, and its division into regular sequences of remains, fills up a period of more than 2000 years before the establishment of the dynastic *régime*, and reveals a wealthy and elaborate civilisation which was already decadent when it was overthrown by the dynastic conquerors. Five different types of man can be distinguished in pre-dynastic times, one of which Prof. Petrie is inclined to identify as Libyan, and akin to a characteristic type in early Greece. The connection of the close of the prehistoric scale of sequences with the early kings has been closely settled by the pottery, and its history shown in the stratified ruins of the earliest town of Abydos; four of the ten kings' names have been found of the dynasty which preceded that of Menes, and also the names of all the eight kings of the dynasty of Menes himself. The growth of the use of writing can be traced on the seals, and the æsthetic revolution which accompanied the establishment of the dynastic kingdom is seen to lead directly to the fixed artistic types which dominate Egypt thenceforward. The Royal tombs likewise are traced in sequence of elaboration from the prehistoric pit grave, first to the brick *mustaba*, and then to the stone-built pyramid of the third dynasty.

At Abydos, on the site of the Osiris temple, ten successive shrines of earlier dates have been unearthed through a depth of 20 feet of soil; the latest is that of Amasis, of the twenty-sixth dynasty, and the earliest that of the first. The principal results were of the last-named period, and included a remarkable school of fine ivory carving, and striking examples of two-colour glazing.

The liberal support which the Association has given throughout to British exploration in Crete was more than justified by the reports of the last season's work. Mr. Duckworth's anthropographic inquiry has been noted already; Dr. Arthur Evans gave a full account of his latest discoveries in the Palace of Knossos, and Messrs. Bosanquet and Myres described the excavation of a pre-Mycenæan town and sanctuary at Palaikastro, in eastern Crete, conducted by the British School of Archæology in Athens, and supported, like the work at Knossos, by the Cretan Exploration Fund.

At Knossos the year's campaign, which was expected to conclude the excavation, took a wholly unlooked-for development, in the discovery, first, of a north-west wing of the palace, including a rudimentary theatre formed by converging staircases, not unlike that found already in the Palace of Phæstos; second, of a detached house to the north-east, with much fine pottery, and a remarkable columnar hall with a *tribuna* and apse at one end, which appears to anticipate the features of the later *basilica*; third, of many scattered deposits between and below the floor levels of the palace, which serve to elaborate and explain the detailed chronology of the whole mass of buildings. One of these deposits, found near the east pillar-room, contained a quite unparalleled accumulation of native-made figurines in a kind of Egyptian glaze-ware, the débris of a sanctuary dedicated to a snake-goddess. In the same deposit occurred also a remarkable marble cross, which seems to have been the central aniconic object of the shrine, and examples of a fresh form of linear script. In view of these important results, it becomes necessary to complete the investigation of the ground below the later floors throughout the palace, as well as to continue the search for the Royal tombs, which has hitherto only led to the discovery of a late and much plundered necropolis to the northward.

At Palaikastro the settlement discovered in 1902 proves to be a considerable town of regular plan, dating from the later Minoan period, with extensive Mycenæan rebuildings. The detailed finds indicate widespread commerce from Egypt to Lipari, and considerable prosperity and comfort at home. The preponderance of submarine subjects in the decorative art suggests that the persistent Cretan sponge industry was already of importance, and a visit paid by Mr. Bosanquet to the island of Kouphonisi, off the south-east coast of Crete, proved the existence of an extensive and clearly pre-Phœnician purple fishery, going back into Minoan times. The pre-Mycenæan sanctuary explored by Mr. Myres on the hill overlooking Palaikastro yielded a remarkable series of votive terra-cottas, and much new evidence as to pre-Mycenæan costume.

The papers on Roman Britain, already mentioned, were as follows:—

Mr. T. Ashby, jun., gave a retrospect of excavations at Caerwent, in Monmouthshire (1899–1903), on the site of the Romano-British city of Venta Silurum, which a recently discovered inscription shows to have been the administrative centre of the Silures in Roman times. The external walls are clearly traceable, with three gates partially preserved, and an inner earthwork which seems to have been the original fortification. The buildings within are chiefly private houses, sometimes wholly enclosing a rectangular

courtyard, an arrangement which is unique in England. Some interesting mosaics have been found, and near the north gate the remains of an amphitheatre *within* the city walls.

Mr. John Garstang described the Roman fortress Bremettenacum (Ribchester), to which an excursion was made in the course of the meeting. Excavations made in 1898–9 have shown that this station was one of a series of fortresses which, with the wall of Hadrian, formed the northern frontier defences of Roman Britain. It is entirely of the earlier character, severely rectangular, with internal buttresses, mural towers, and double-arched gates, and filled within with rows and streets of stone-built barracks and stables.

Mr. Garstang also gave a preliminary account of the Roman fort at Brough, where exploratory excavations have been made quite recently. Like Ribchester, it belongs to the earlier type of fort, and was situated in the favourite position at the junction of two streams. In clearing a deep enclosure within the walls, two inscribed altars were found, and portions of a large inscribed tablet set up by a Præfect of the First Cohort of Aquitani under Julius Verus, Governor of Britain in the time of Antoninus Pius.

The committee on excavations on the Roman site at Gellygaer, near Cardiff, reported that the work was now completed, the results published, and the movable finds installed in the Cardiff Museum.

The committee appointed to report on the excavations at Silchester summarised the last season's work, and strongly urged that, in the small part of the site which remains to be explored, special care should be taken to secure accurate registration of the stratification (if any exists) of the smaller finds, and to investigate the relation in which the rectangular street plan stands to the irregular trapezium of the town wall.

As a result of this and similar recommendations, the Silchester committee of the Association has been reconstituted as a committee "to cooperate with local effort on Roman sites in Britain," and starts work anew with a small grant, to be expended in facilitating special researches of the kind suggested at Silchester, on sites where local or other subscriptions are already providing the funds for a general exploration. The opportunities for work already offered at Silchester on the plant-remains, the frequent occurrence on Roman sites of animal or human bones which need special precautions and expert examination, and the necessity for more detailed and accurate registration of the smaller finds than has been customary hitherto, even in the best conducted excavations, are examples of classes of observation which are only too liable to be neglected by local explorers, and the committee will be doing good service if it can secure for them the attention which they deserve.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—An examination in mathematics and physics will be held at St. John's College on March 16, 1904, for the purpose of electing a fellow in those subjects. Candidates will be given an opportunity of showing their knowledge of experimental physics. All persons are eligible who shall have passed all the examinations required for the degree of Bachelor of Arts on the day of election (April 20).

CAMBRIDGE.—The general board of studies has issued a report proposing a more comprehensive organisation of geographical studies and examinations in the university. The proposals include the establishment of a board of geographical studies, a geographical education fund, to which the university and the Royal Geographical Society each contribute 200*l*. a year, a special examination in geography for the ordinary B.A. degree, and a diploma in geography for advanced work in the subject. The stipend of the reader in geography is fixed at 200*l*., and his lectures and those of the other teachers to be employed will be under the direction of the board, on which the council of the Royal Geographical Society will be represented.

A memorial urging the desirability of some similar organisation of anthropological study has been presented by thirty members of the senate, and is at present under the consideration of the council.

Twenty-two candidates have passed the half-yearly examination in sanitary science, and have thus become entitled to the university diploma in public health.

On October 21, 886 freshmen, including 13 "advanced students," were matriculated. The corresponding number for last year was 868.

Mr. F. F. Blackman, St. John's, has been appointed deputy for the reader in botany, Mr. F. Darwin, F.R.S.

The Ven. E. H. Gifford, D.D., senior classic and fifteenth wrangler in 1843, has been elected an honorary fellow of St. John's College.

The grace for the establishment of the Stokes lectureship and the Cayley lectureship in mathematics, for which a temporary endowment was recently offered to the university by certain anonymous donors, will be offered to the senate to-day (October 29).

MR. R. J. T. BRYANT, Leyton Technical Institute, has been appointed organiser of higher education to the Borough of Lowestoft.

IT is stated in the *Petit Journal* that Harvard University has come into possession of a legacy of about 5,000,000*l*., the whole of the estate of the late Mr. Gordon Mackay.

ON the invitation of Yale University, Prof. Sherrington, F.R.S., of Liverpool University, has undertaken to deliver the second series of Silliman memorial lectures next year.

PROF. H. S. HELE-SHAW, F.R.S., has been appointed, through the Colonial Office, to organise technical education in the Transvaal and the Orange River Colony, and to consider the future university scheme of these colonies. The appointment is not a permanent one, and Prof. Hele-Shaw has been granted leave of absence by the council of the University of Liverpool until September next.

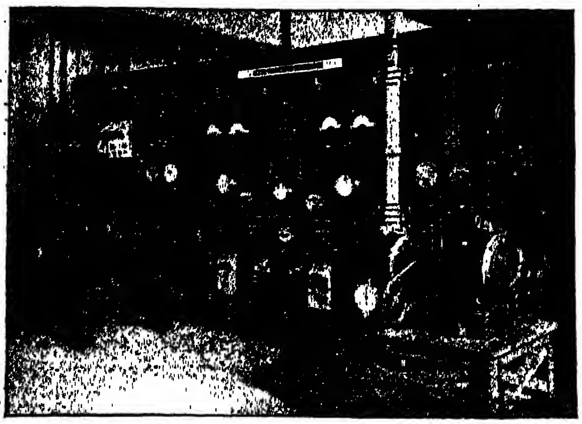
THE County of Essex Education Committee announces that an elementary course of instruction in dairy bacteriology will be given in its biological laboratories at Chelmsford. The course will commence on Thursday, November 5, and will be continued on the ten succeeding Thursdays. The course seems to be a comprehensive one, and should be of considerable value. Normal classes for the training of teachers in natural and experimental science have also been instituted by the committee at Chelmsford. These classes are intended for the practical instruction and training of persons resident in Essex who desire to qualify themselves to teach under the County Council. The classes meet on Saturdays from 10 to 5 o'clock during the winter months.

THE inaugural address to the students of the medical department of University College, Sheffield, was delivered by Sir Michael Foster, K.C.B., on October 15. He directed attention to the variety and complexity of the studies considered necessary for medical students; and he remarked that the question whether the burden was becoming too great for the student, and what things in the curriculum could with advantage be thrown on one side, must be considered, for the least important subjects would have to give way in the future.

THE Home Counties Nature-Study Exhibition will be opened in the offices of the Civil Service Commission, Burlington Gardens, W., to-morrow, October 30, at 3 p.m. Lord Avebury will preside. Admission tickets at special rates can be obtained by teachers and pupils by application to the honorary secretary, Mr. W. M. Webb, 20 Hanover Square, W. The programme includes conferences for teachers on practical methods of nature-study in elementary and secondary schools. The latest scientific developments of the Urban-Duncan microbioscope will be shown on the evenings of Friday and Saturday, and well-known lecturers on natural history subjects, such as Mr. Douglas English, Mr. Richard Kearton, Mr. R. B. Lodge, and Mr. Oliver Pike will give addresses from time to time, and exhibit their slides during the exhibition. Special meetings of the Middlesex Field Club and Nature-Study Society and of the Selborne Society will be held at the exhibition on Monday and Tuesday.

WE have received an admirably illustrated booklet describing the Montefiore Electrotechnical Institute of the University of Liége, and containing a programme of the courses of instruction. In glancing through the illustra-

tions, one is struck by the excellence of the equipment of the laboratories and workshops. We reproduce on a reduced scale an illustration showing the installation for the study of synchronous motors and problems connected with the paralleling of alternators. The character of the wiring is a noticeable feature; the switchboard looks more like a diagram than an actual board, having all the leads plainly visible and easily accessible, which must prove a considerable advantage in teaching and experimental work. The apparatus and machinery installed cover practically the whole field of electrotechnical measurements, a separate



One of the laboratories at the Montefiore Institute.

installation, complete in itself, being provided for the study of each branch. In addition to these "industrial laboratories" there are well-equipped standardising laboratories, chemical and photometric laboratories, drawing offices, and lecture theatres. Altogether the institution appears to be thoroughly equipped for teaching electrical technology.

SOCIETIES AND ACADEMIES.

Manchester.

Literary and Philosophical Society, October 6.—Prof. W. Boyd Dawkins, president, in the chair.—Dr. Henry **Wilde**, F.R.S., read a paper on the resolution of elementary substances into their ultimates and on the spontaneous molecular activity of radium. The author referred to several of his papers published by the Society on the genesis of elementary substances and on the multiple proportions of their atomic weights, wherein certain gaps appeared in the several series in his tables, which have since been filled up by scandium, germanium, helium, argon, neon, krypton and xenon. The remarkable properties of radium were held to represent further realisations of the predictions made in the author's earlier papers. The author had previously indicated the interruption in the regularity of his multiple series $H2n$ through the absence of elements of atomic weights 160 and 184 respectively. As there is only one place vacant higher in this series for an analogue of calcium, strontium and barium, radium was identified by the author as the tenth elementary condensation of $H2n$, with an atomic weight of 184, and a specific gravity of 4·8, as shown in his tables. The author had shown in former papers that helium was the unknown typical molecule of the same series, with an atomic weight of 2, and had previously indicated the probability of the resolution of the higher members of each series into their elementary typical molecules. The production of helium from radium by Profs. Rutherford, Soddy and Ramsay confirmed the author's prevision in the case of the series $H2n$, and this result may lead to the resolution of the higher members of other series into their ultimates.—Fossil plants from the Ardwick series of Manchester, by Mr. E. A. Neville **Arber**. The author has carefully reinvestigated the fossil plants from the Ardwick series of rocks collected by the late Mr. Binney, and which are now in the University Museum of Cambridge. He has also examined the numerous fossil plants from this series in the Manchester Museum, and has come to the conclusion that the Ardwick series of rock does not belong, as stated, to the Upper Coal-measures, but forms a definite transition series between the Upper and Middle Coal-measures of Lancashire. Such a transition series has been already recognised in the Coal-measures of South Wales, Somerset, and Staffordshire.

October 20.—Prof. W. Boyd Dawkins, president, in the chair.—Mr. Henry **Sidebottom** read a paper on recent Foraminifera from the coast of the island of Delos, in which he enumerated some seventy species of Miliolidæ, including four new species and several interesting variations. The new species and variations were fully described, and drawings both of the specimens and their sections exhibited. Mr. Sidebottom stated that the dredgings from this locality were extraordinarily rich in Foraminifera.

Paris.

Academy of Sciences, October 19.—M. Albert Gaudry in the chair.—On the state of vaporised carbon, by M. **Berthelot**. At a temperature of 1200°–1500°, carbon possesses an appreciable vapour pressure, which is so small that, even after several hundred hours in a vacuum, the amount vaporised amounts only to a few milligrams. This carbon is amorphous, and contains no trace either of diamond or graphite.—On the periods of double integrals and their relations with the theory of double integrals of the second species, by M. Émile **Picard**.—On the estimation of argon in atmospheric air, by M. Henri **Moissan**. Pure metallic calcium, prepared by a method previously described by the author, is used to absorb the nitrogen; this metal also absorbs the traces of hydrogen which are always present if a mixture of lime and magnesium powder has been used in the preliminary treatment. Samples of air from various sources gave, with one exception, very concordant figures between 0·931 and 0·938 per cent. by volume, the exception being a sample of air taken on the Atlantic, which gave 0·949 per cent.—On the products of condensation of tetramethyldiamidophenyloxanthranol with benzene, toluene, and dimethylaniline, by MM. A. **Haller** and A. **Guyot**.—On the acclimatisation and culture of pintadines, or true pearl oysters, on the coasts of France, and on the forced production of fine pearls, by M. Raphaël **Dubois**. Successful experiments have been carried out with *Margaritifera vulgaris*, which has been acclimatised and made to yield pearls which, although small, are of good quality.—On linear equations of finite differences, by M. Alf. **Guldberg**.—On a reflection refractometer, by M. Th. **Vautier**. An interference refractometer composed of three mirrors is described, allowing of the complete separation of the two interfering light bundles.—On the composition of zinc peroxide, by M. **Kuriloff**. The only definite peroxide of zinc appears to be $ZnO_2.Zn(OH)_2$.—The phagocyte organ of the crustacean decapods, by M. L. **Cuénot**.—On the phases of folding in the French intra-alpine zones, by M. W. **Kilian**.—The part played by compression in the localisation of the tendons, by M. R. **Anthony**.—On the relations existing between the Surra and the Nagana, according to an experiment of Nocard, by MM. **Vallée** and **Carré**. The authors confirm the views of MM. Laveran and Mesnil as to the non-identity of Surra and Nagana.—Parthenogenesis and treatment of rheumatism, by M. L. **Pénières**.—Experimental researches on the sense of smell in the old, by M. **Vaschide**. In old people the sense of smell is better preserved in women than in men, but in all cases there is a marked diminution in olfactory sensibility due to age.

New South Wales.

Royal Society, August 5.—Mr. F. B. Guthrie, president, in the chair.—The economic effects of sanitary works, by Mr. J. Haydon **Cardew**. The principal object of the paper was to give municipal and health authorities some basis to work upon in devising sanitary services and forecasting their economic effects.—On the protection of iron and other metal-work, by Mr. William M. **Hamlet**. The author dealt with an investigation of the causes of the rapid rusting away of the iron casing at one of the Australian artesian bores, where abundance of carbonic acid gas was evolved at 100° F.; the water also contained alkaline carbonates and bicarbonates with sodium chlorides, silica, &c., amounting to between thirty and forty grains of total solid matter to the gallon. Probably a specially hard and resistant alloy

will be required to stand the prolonged and severe action of the water in question.—On the elastic radial deformations in the rims and arms of flywheels, and their measurement by an optical method, by Mr. A. **Boyd.** In this paper actual measurements of the deflections of the rims during rotation were given, so that the shape of the rim at any speed within the elastic limit of the material could be seen. The flywheels tested were of different design. The curves for a curved armed wheel showed a large inflection between the arms, the maximum deflection being close to the arms. The tests on four armed wheels showed very clearly the great advantage of having the joint along the arms, the effect of the joint in a four-armed wheel, jointed along the arms, being in fact almost negligible.—The aboriginal fisheries at Brewarrina, by Mr. R. H. **Mathews.**

September 2.—Mr. F. B. Guthrie, president, in the chair.—The following papers were read:—The separation of iron from nickel and cobalt by lead oxide (Field's method), by Mr. T. H. **Laby.** An inquiry into the accuracy of Field's method, as it has distinct advantages over methods commonly in use, viz. a *single* precipitation of the iron, and the absence, after the removal of added lead, of all reagents, such as sodium or ammonium salts. Combined with the electrolytic determination of nickel or cobalt, the method becomes rapid. Standard solutions of carefully purified iron, nickel, and cobalt nitrates were prepared. With these solutions twenty-two analyses were made, showing a recovery of more than 99 per cent. of nickel and cobalt.—Pot experiments to determine the limits of endurance of different farm-crops for certain injurious substances, part ii., maize, by Messrs. F. B. **Guthrie** and R. **Helms.** The authors communicated the results of experiments having for their object the determination of the tolerance of maize for sodium chloride, sodium carbonate, ammonium sulphocyanide, sodium chlorate, and arsenious acid.—Bibliography of Australian lichens, by Mr. E. **Cheel.**—On the Narraburra meteorite, by Prof. **Liversidge,** F.R.S. A general account of the characteristics of this metallic meteorite, weighing more than 70 lb., which was discovered in 1855 on the Yeo Yeo Creek, twelve miles east of Temora, N.S. Wales.

Linnean Society, August 26.—Dr. T. Storie Dixson, president, in the chair.—Studies in Australian entomology. No. xii. New Carabidæ (Panageini, Bembidiini, Platysmatini, Platynini, Lebiini, with revisional lists of genera and species, some notes on synonymy, &c.), by Mr. T. G. **Sloane.**—Revision of the Australian Curculionidæ belonging to the subfamily Cryptorhynchides, part vi., by Mr. A. M. **Lea.**—Notes on *Byblis gigantea*, Lindl. [N.O. Droseraceæ], by Mr. Alex. G. **Hamilton.**

DIARY OF SOCIETIES.

SATURDAY, OCTOBER 31.

ESSEX FIELD CLUB, at 6.30.—Exhibition of a Series of Photographs of Fungi, by means of the Lantern: Mr. Somerville Hastings.—Seed Dispersal: Prof. G. S. Boulger.

MONDAY, NOVEMBER 2.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—On the Application of the X-Rays to the Examination of "Safety Fuses": C. Napier Hake.—Scarlet Phosphorus—A New Chemically Active Variety of Red Phosphorus, and its Use in the Manufacture of Matches: Drs. Marquart and Schulz.—New Compound of Phosphorus for the Production of Matches: F. Bale.—Densities of Concentrated Nitric Acid at different Temperatures: Prof. V. H. Veley, F.R.S., and J. J. Manley.—On a Comparison of Different Types of Calorimeters: J. S. S. Brame and Wallace A. Cowan.

TUESDAY, NOVEMBER 3.

ZOOLOGICAL SOCIETY, at 8.30.—On some New Species of Aquatic Oligochæta from New Zealand: Prof. W. B. Benham.—List of the Mammals collected by Mr. A Robert at Chapadá, Matto Grosso. (The Percy Sladen Expedition to Central Brazil): Oldfield Thomas, F.R.S.—List of the Coleoptera collected by Mr. A. Robert at Chapadá, Matto Grosso. (The Percy Sladen Expedition to Central Brazil): C. J. Gahan and G. J. Arrow.

WEDNESDAY, NOVEMBER 4.

GEOLOGICAL SOCIETY, at 8.—Metamorphism in the Loch Lomond District: E. H. Cunningham-Craig.—On a New Cave on the Eastern Side of Gibraltar: Henry Dyke Acland.

ENTOMOLOGICAL SOCIETY, at 8.—On some Aberrations of Lepidoptera: Percy I. Lathy.

SOCIETY OF PUBLIC ANALYSTS, at 8.—On the Salinity of Waters from the Oolites: W. W. Fisher.—Notes on (1) Some Indian Oils; (2) Differentiation of Linseed Oil from Boiled Oils: Dr. J. Lewkowitsch.—Note on the Purification of Hydrochloric Acid and Zinc from Arsenic: Dr. L. T. Thorne and E. H. Jeffers.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Northern Nigeria: Sir Frederick D. Lugard, K.C.M.G.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 5.

CHEMICAL SOCIETY, at 8.—Conductivity of Substances Dissolved in Certain Liquefied Gases. Preliminary Notice: B. D. Steele and D. McIntosh.—The Reduction of Hydrazoic Acid: W. T. Cooke.—The Behaviour of Metallic Oxides towards Fused Boric Anhydride: C. H. Burgess and A. Holt, Jun.—Some Reactions of Vanadium Tetrachloride: B. D. Steele.—Studies on Comparative Cryoscopy. Part I.: The Fatty Acids and their Derivatives in Phenol Solution: P. W. Robertson.—The Vapour Pressures of Sulphuric Acid Solutions. Preliminary Note: B. C. Burt.—The Viscosity of Liquid Mixtures. Preliminary Note: A. E. Dunstan and W. H. C. Jemmett.—Additive Compounds of s Trinitrobenzene and Alkylated Arylamines: H. Hibbert and J. J. Sudborough.—A Contribution to the Study of the Reactions of Hydrogen Peroxide: J. McLachlan.—The Constitution of Certain Silicates: C. Simmonds.—Constitution of Ethyl Cyanacetate. Condensation of Ethyl Cyanacetate with its Enolic Form: P. Remfry and J. F. Thorpe.—Interaction between Chloric and Hydriodic Acids: J. McCrae.—3:5:-Dichloro-1:1:2-Trimethyldihydrobenzene. A Correction: A. W. Crossley.—The Estimation of Hydroxylamine: H. O. Jones and F. W. Carpenter.—A Study of the Isomerism and Optical Activity of Quinquevalent Nitrogen Compounds: H. O. Jones.—The Action of Water and Dilute Caustic Soda Solutions on Crystalline and Amorphous Arsenic: W. T. Cooke.—The Union of Carbon Monoxide and Oxygen, and the Drying of Gases by Cooling: A. F. Girvan.

RONTGEN SOCIETY, at 8.30.—President's Address.

LINNEAN SOCIETY, at 8.—On the Structure of the Leaves of the Bracken, *Pteris aquilina*, in relation to environment: L. A. Boodle.—On the Life-history of a New Monophlebus from India, with a Note on that of a Vedalia predaceous upon it; with Remarks on the Monophlebinæ of the Indian Region: E. P. Stebbing.

FRIDAY, NOVEMBER 6.

GEOLOGISTS' ASSOCIATION, at 8.—Conversazione at University College.

CONTENTS.

PAGE